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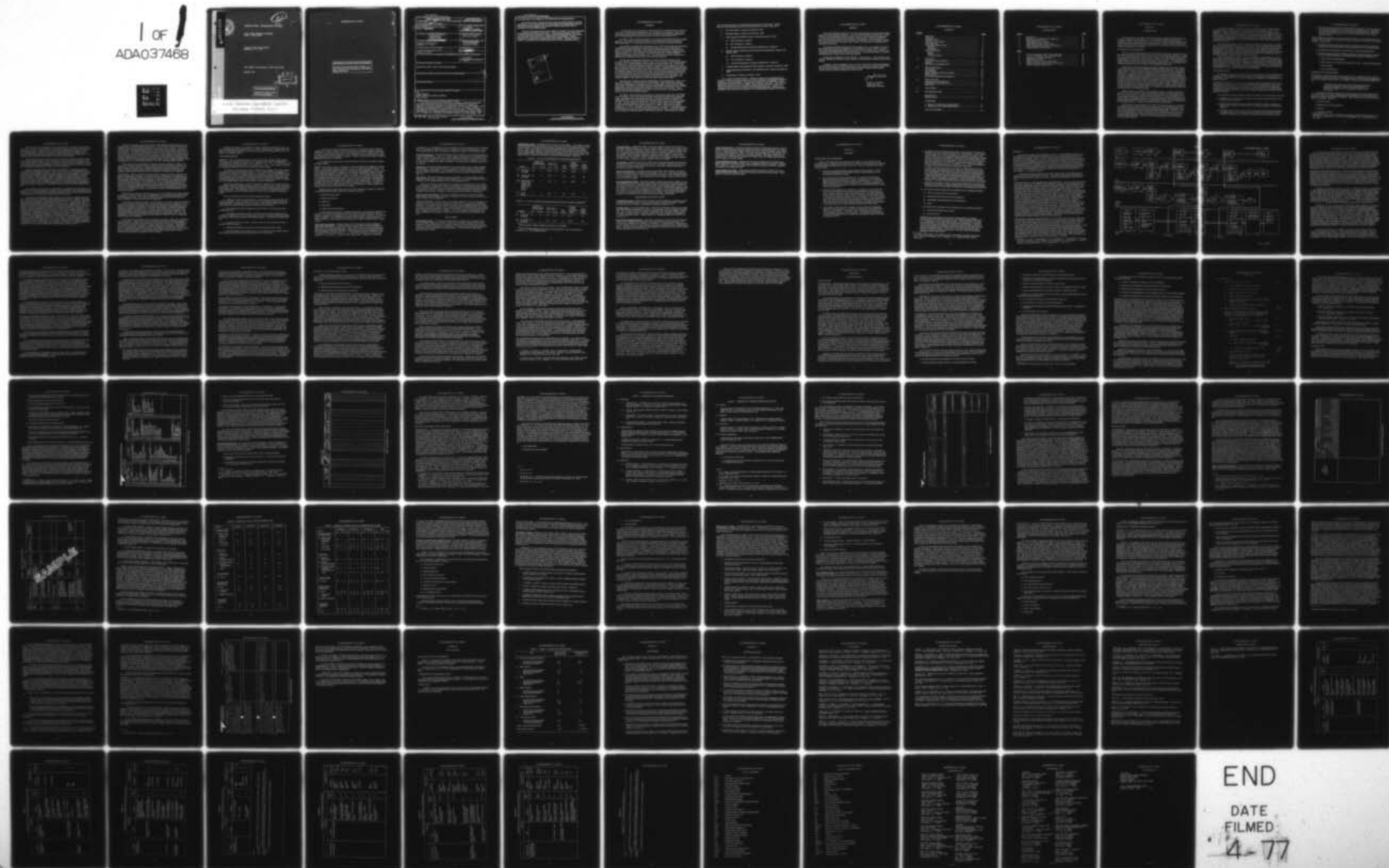

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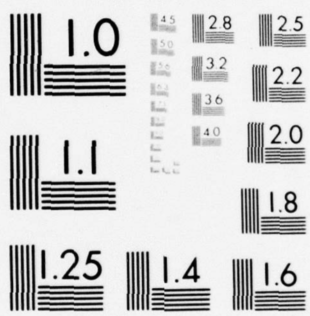

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TECHNICAL REPORT: NAVTRAEQUIPCEN 75-C-0099-1

A-6E SYSTEMS APPROACH TO TRAINING PHASE I FINAL REPORT

Grumman Aerospace Corporation
Bethpage, N. Y. 11714

Final Report for period April 1975 to May 1976

February 1977

NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

18

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

19

1. REPORT NUMBER: NAVTRAEQUIPCEN 75-C-0099-1
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): 6 A-6E Systems Approach To Training, Phase I, ~~Final Report~~
5. TYPE OF REPORT & PERIOD COVERED: 9 Final Report, Apr[redacted]975 - May [redacted]976,
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): 10 Samuel C. Campbell, Joseph Feddern, George Graham, Martin Morganlander
8. CONTRACT OR GRANT NUMBER(s): N61339-75-C-0099-1 new 15
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Grumman Aerospace Corp. Bethpage, N.Y. 11714
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NAVTRAEQUIPCEN Project No. 5753-01
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Training Equipment Center Orlando, Fl 32813 12 96p.
12. REPORT DATE: 11 Febr[redacted]977
13. NUMBER OF PAGES: 88
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

ISD
Media Analysis
Specific Behavioral Objectives (SBO's)
Task Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes one of four Phase I programs, namely the A-6E TRAM Instructional Systems Development (ISD) Program, established to evaluate the application of a Systems Approach to Training (SAT) in Naval aircraft programs. The research and development goals of this program were to: (a) evaluate a variety of ISD methods and procedures as applied to the aircrew training, (b) achieve a better understanding of the constraints and operating conditions that affect aircrew training, and (c) acquire cost, scheduling, and manpower data for future ISD planning. The

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operational goal was to design an A-6E TRAM aircrew training program.

The approach used to achieve the above goals conformed basically to the ISD methodology. The report discussed the Task Analysis, the development of Specific Behavioral Objectives (SBOs), the selection of instructional media, and the formulation of Lesson Specifications.

The role of the Subject Matter Expert (SME) is reviewed, as is the requirement for quantitative standards of performance. The operational aspects of the A-6E Training Program are addressed: program costs and manpower data are included. Specific media requirements and recommendations are presented. Generic descriptions of appropriate training devices are provided. The report includes a number of conclusions and recommendations and a 30-item reference section.

SUMMARY

The following report describes the effort and results of the application of a Systems Approach to Training (SAT) during Phase I of a two-phase R & D program. Phase I was accomplished under contract N61339-75-C-0099 and followed the guidelines established in Naval Training Equipment Center Specification N-215-254, dated October 1974.

The Phase I effort involved the design of an A-6E Pilot and Bombardier (B/N) training program. The approach conformed basically to the Instructional Systems Development (ISD) methodology i.e., first analyze the job and then design the training to fit the job.

The analysis encompassed the identification of all A-6E Pilot and B/N job performance requirements and the determination of those job performance activities that must be trained in the Readiness Squadron. This resulted in the documentation of Pilot and B/N tasks to be trained and task related factors that might affect the priorities assigned within training program i.e., task criticality, frequency of occurrence, inherent difficulty, changes in knowledge and skill required, etc. Also identified were those activities more appropriately introduced and practiced in the operational squadron.

The next step, designing the instruction, involved; (a) the determination of the criterion objectives and criterion reference tests, (b) the selection of instructional methods and media, and (c) the identification and formulation of instructional units. With the help of a Taxonomy of Training Objectives specifically developed for this program, the Pilot and B/N Task Listings were analyzed to develop terminal or enabling behavioral statements. These statements, along with the corresponding operational standards and conditions formed the substance of the Criterion Objectives. The criterion reference tests were determined by carefully examining the behavioral statements, the operational standards and the operational conditions with respect to the training environment and the selected media. The resulting Criterion Test Statements became the final element in the construction of the Criterion Objective; also referred to as Specific Behavioral Objective (SBO).

The final order of business was the identification of instructional units. Here, as in many other instances, the Navy SMEs were very helpful. They assisted in identifying instructional phases and in organizing the SBOs into meaningful instructional units within these phases. The SBOs were further sequenced within these units and then tied to training media and preliminary instructional strategies to form lesson specifications. These specifications provide the guidelines for initial learning, practice, and testing for each lesson in the A-6E Pilot and B/N syllabus.

The Phase I study resulted in the design of an instructional system for A-6E TRAM aircrew training. In all, over 700 Pilot and B/N tasks were identified; 400 normal pilot tasks, approximately 200 normal B/N tasks and 110 airframe emergency and system malfunction tasks. More than 370 Specific Behavioral Objectives were identified; 105 for the Pilot, 109 for the B/N and 159 for both. Generic types of media were recommended to support Specific Behavioral Objectives training as follows; Audio-visual 323 SBOs, Visual Aids - 252 SBOs, Environmental Media (e.g., WST) - 363 SBOs, Operational Equipment (e.g., A/C) - 176 SBOs, and Tutorial Media - 139 SBOs. Lesson Specifications for 55 lessons were developed, with 19 designated for pilot training, 17 for B/N training and 19 lessons for training common to both the pilot and B/N. The following is a listing

of the documents prepared and submitted during the course of this study. Further detail on this documentation can be found in the reference section of this report.

a. Work Plan Report, Contract Line Item No. 0001

b. Quarterly Reports, Contract Line Item No. 0002

c. Task Listing A-6E TRAM Aircraft, Contract Line Item No. 0003

  (a) Pilot Procedures, Volume I

  (b) B/N Procedures, Volume II

  (c) Airframe Emergencies and System Malfunctions, Volume III

d. Specific Behavioral Objectives and Criterion Test Statements, Contract Line Item No. 0004

  (a) Pilot Procedures, Volume I

  (b) B/N Procedures, Volume II

  (c) Airframe Emergencies and System Malfunctions, Volume III

e. Training Support Requirements (Media Analysis), Contract Line Item No. 0005

f. Lesson Specification Documents A-6E TRAM Aircraft, Contract Line Item No. 0006

g. Final Report, Contract Line Item No. 0007

As a result of performing Phase I, sufficient evidence exists indicating that the design of an aircrew training program may be more efficiently accomplished through the application of ISD methodology. It also became evident that it is inefficient to employ operationally oriented personnel in lengthy, highly analytical ISD tasks. They are more effectively utilized as sources of technical and operational expertise. Based on the conclusions reached and the problems encountered during this study, specific recommendations were made and are contained in the Recommendations Section of this report.

PREFACE

This A-6E TRAM ISD Program is one of four such programs currently under development for the Naval aviation community. The overall project began in March of 1974, when the Naval Training Equipment Center awarded a contract for the design and development of an aircrew training program for the SH-2F LAMPS aircraft. This was followed in April with similar contracts for the A-6E TRAM, EA-6B ICAP and E-2C weapons systems. The contracts called for a two phased effort, Phase I of which has been completed and is described in this report.

The research and development goals of this project are to: (a) evaluate a variety of ISD methods and procedures as applied to several different aircraft systems, (b) define the constraints and operating conditions that impact aircrew training, and (c) acquire cost, scheduling, and manpower data for future ISD planning. The operational goal is to develop and implement four viable aircrew training programs.

Special acknowledgement is due to Captain C. Jasper and Mr. I. May of AIR-413 and LCDR P. Chatelier of AIR-340 for their assistance and cooperation during the course of this project.

In addition, special recognition is due to VA-42, NAS Oceana, which was designated model manager for the A-6E TRAM program and to the instructor personnel of both VA-42 and VA-128, NAS Whidbey Island, who reviewed all interim outputs and provided invaluable technical support throughout the Phase I effort.

Joseph F Funaro

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SECTION I

INTRODUCTION

The first phase of a two-phase study which has as its purpose the application of the Systems Approach to Training (SAT) in the A-6E (TRAM) aircraft program has been completed. Phase I effort involved the use of the Instructional Systems Development (ISD) process through the design stage and is reported herein. Follow-on Phase II effort will complete the study and will continue the application of the ISD process through the training program development and evaluation.

STATEMENT OF THE PROBLEM

A review of naval safety records over the past five or six years, indicates that more than 1000 crewmen and 1200 aircraft have been lost through operational mishaps. In addition to the immeasurable cost of life, losses in excess of two billion dollars in investments in equipment and training have been incurred. Human error, often preventable through better training, accounted for a great percentage of these mishaps. The capabilities of the modern weapon system, enabled by rapid advances in technology, pose a challenge to the traditional training methods to continue ensuring qualified aircrewmen.

Until recently, the general tendency in aircrew training has increasingly reflected technological improvements in designing and building training equipment. The training program itself, however, tended to develop in increasing isolation from the operational requirements. Training needs and requirements were not always carefully analyzed or interpreted, resulting in ill-defined specifications for training programs and equipment. Curricula for training programs operating for many years became outdated or burdened by numerous instructional units appended to (but not integrated with) the existing program. Moreover, these units tended to reflect the peculiar and subjective experiences of the individual instructor as to what and how much should be taught. Syllabi schedules, and the content that needed to be covered, tended toward becoming a primary concern of the instructors, rather than the learning achieved by the trainee. Training media, equipment, courses and lessons received little follow-on evaluation to ascertain their appropriate use and effectiveness in the training program.

Military leaders, responsible for the quality of training, recognized and became acutely aware of this dangerous trend toward isolation of their training programs from their very "raison d-etre," to ensure effective performance in the operational mission. The potential consequences of this trend, if unchecked, are: increased equipment costs without proven corresponding increase in training effectiveness, increased training time without verified performance improvement and tendency towards increased irrelevancies in the training program. These were readily perceived as intolerable.

Alternatively, a renewed emphasis was placed on a systems approach, attempting to integrate operational requirements with training objectives, and training objectives with both training hardware and software design and training system evaluation. Application of the Instructional Systems Development (ISD) methodology to a number of aircrew training programs, both for aircraft still in the developmental phase, as well as for some already operational, has provided sufficient evidence of training benefits to warrant further application, in this case, to the training program for aircrewmen of the A-6E TRAM aircraft.

A-6 aircrew training is conducted at VA-42, Oceana and VA-128, Whidbey Island. These squadrons are in the process of accepting A-6 aircraft modified to an A-6E configuration. TRAM modifications are expected shortly. Programs of training at these squadrons are being conducted at high levels of effectiveness and the application of the ISD process thereto in no way reflects dissatisfaction with their accomplishments. Because of the imminent modifications to the squadron aircraft, the opportunity exists for updating the program via an ISD approach, with the expectation that a good training program can always be made better.

A second major problem, always of concern to military training officers, but which has become increasingly critical, is that of economics. Costs associated with the deployment of operational vehicles for training purposes have been increasing at alarming rates. Spiraling fuel costs, added to inflationary increases in parts replacement and aircraft maintenance, have driven the cost of a single aircraft turnaround into thousands of dollars. Movement of a group of A-6 pilots and bombardier/navigators (B/N) through the current Readiness Squadron syllabus includes hundreds of flights.

While acknowledging the efficacy of hands-on training, it is imperative that the extent of use of operational aircraft in a training mode be fully justified. Moreover, where appropriate, less costly methods of training, e.g., Weapon System Trainers (WST) should share the burden of in-flight training. Application of ISD technology, with precise identification of performance requirements, standards, and training objectives, can help provide hard justification for use of operational aircraft; what's more, it can assess the trade-off of using WSTs or other media to supplement training flights.

STUDY OBJECTIVES

It is the intent of this study to apply ISD-SAT methodology to the A-6E TRAM aircraft program, with the expectation of achieving a twofold set of benefits, operational and developmental. Attainment of most of these benefits, as indicated below, depends upon completion of Phase II.

OPERATIONAL BENEFITS. A-6 aircrew training is currently being conducted at VA-42, NAS, Oceana, Virginia, and at VA-128, NAS, Whidbey Island, Washington. Introduction of TRAM aircraft modifications is expected later. These modifications, identified and described in succeeding subsections, will require some changes in the A-6 training program. Application of the ISD methodology to the entire program is expected to yield the following operational benefits:

- Comprehensive ground and flight syllabi for training of A-6E aircrewmen (Phase II)
- Detailed lesson specifications including recommended instructional media to support these lessons (Phase I)
- Recommended training program organized and tailored to satisfy operational activities under operational conditions and to operational standards of performance (Phase II)
- Training program, which by virtue of its systematic development and traceability of training requirements, enables program evaluation and content improvement through both qualitative and quantitative measurement and test (Phases I and II)

- Training program which provides more effective utilization of available manpower and resources through early, well-defined training objectives, and a systematic, goal-oriented progression of activities leading to those objectives. Superfluous and irrelevant training program materials are excluded from the curriculum (Phases I and II).

DEVELOPMENTAL BENEFITS. The developmental benefits to be accrued from this ISD program apply to the ISD as a methodology as well as directly to the A-6E aircrew training program. They include:

- ISD approach which allows determination and justification of need for additional training hardware (See Section III, Media Analysis) for the A-6E TRAM program
- Specification of the functional characteristics of required training devices
- Provides additional ISD data permitting evaluation of the effectiveness of application of the ISD methodology to an existing training program, with respect to:
  - quality of the resulting program
  - benefits in terms of savings in training hours, costs, or improved performance
  - user acceptance
  - cost of implementation

INSTRUCTIONAL SYSTEM DESIGN

DEFINITION. Instructional System Development (ISD) is a methodology which is gaining increasingly widespread attention and use among the various military training organizations as well as within the civilian sector. It is defined in AFM 50-2 and AFP 50-58 (page 1-2) as:

> "a deliberate and orderly process for planning and developing instructional programs, which insures that personnel are taught the knowledges, skills and attitudes essential for job performance."[1]

Encompassed within this definition are four key features, both implicit and explicit, which, when taken as a totality, distinguish the ISD approach from more traditional approaches to instructional program development. These features are not so much unique in kind as in emphasis. They are:

- Job performance
- Deliberate and orderly approach
- Process
- Teaching essentials

[1] Department of the Air Force, Handbook for Designers of Instructional Systems, Vol. 1: Introduction, Headquarters, U.S. Air Force, Washington, D.C., Report AFP 50-58, Jan. 1974.

First, ISD uses as its foundation a rather obvious tenet: what needs to be trained is what needs to be done. Job performance in the field provides the solid base upon which the ISD process is begun. Either by survey of related occupational areas (where training is to be developed for a new job) or by job analysis (where field data is available), this approach identifies the critical training tasks, ensuring that precious training time is not wasted on tasks which have little impact on adequate job performance.

Field performance also is used to supply the criteria or standards of behavior appropriate for the training situation. Here tendencies to demand levels of performance in excess of those which are truly required are avoided. At the same time, the trainee, as well as the instructor is aware of the specific goals the trainee is expected to achieve, allowing full concentration and dedication of effort to relevant activities.

Secondly, the ISD process is systematic in its approach. Deliberate and orderly development is emphasized throughout. Each step of the process can be logically derived or related to the preceding one, and is usually documented for accountability. All assumptions are clearly specified to allow objective evaluation and judgment about conclusions drawn therefrom. This systematic feature is highlighted in the development of the behavioral hierarchy, in which all the skills, knowledges and attitudes important to job performance are extracted and identified from analysis of the operational job performance. This again allows an orderly, logical development of the training program, teaching what needs to be taught, but only that. All training offered must have a specific training objective.

The systematic approach offers an opportunity for meaningful trade-off analyses to be performed. Each unit or grouping of training, being well-defined, can be assessed for the relative value of that training to job performance against the costs associated with achieving that training, both in terms of time and investment of resources.

As a process, considerable emphasis is placed on the dynamic, iterative aspects of ISD. Each of the major activities comprising the process involves a feedback loop, updating, modifying, evaluating or verifying the preceding activity. As a process, it provides guidelines (rather than strict rules) emphasizing the "how to", rather than the "what", in planning and developing the training program. While precisely identifying what needs to be taught (and learned), the level of competence that needs to be achieved, what it will cost to get there, and what acceptable alternatives are available to the program manager, considerable latitude is allowed in how to get there. This permits training programs to be developed with comparable effectiveness and efficiency for small or large instructional group presentations or individual, self-paced, programmed instruction. Furthermore, the use of alternative methodological techniques, even within the same program or for the same lessons, are often suggested by the process. This feature is particularly welcome to the military instructor who must be able to respond to dynamic, often unpredictable changes in the training schedule and situation, to wit, weather, down aircraft or trainers, personnel reassignments, etc. The ISD approach thus allows modification of the training program by changes in use of resources rather than by eliminating or reducing content.

Finally, ISD identifies clearly all the skills, knowledges and attitudes that need to be taught in order to ensure adequate performance. This, obviously, does not include all the activities which comprise the jobs addressed, namely that of pilot and B/N. The ISD approach involves early identification of tasks for which skills and knowledges are already in the repertoire of the individual beginning training, either because of prior training or because they are so common as not to require training. It also identifies tasks for which only partial training need be attained (further improvement toward achieving an operational performance standard level can occur in next assignment) or which because of relatively long periods of non-use between training and application might be better taught immediately prior to application (e.g., in operational squadron). All tasks remaining require training.

Using task-related characteristics or features such as complexity of activity, frequency of occurrence, impact on safety of flight if performed marginally or omitted, and relationship to mission success, a training requirements analysis is performed. The result is a "priority" listing of tasks which the designer uses to ensure that all essential training is appropriately planned and that the allocation of training time is optimized.

BACKGROUND. ISD is a remarkably eclectic system, having evolved from advances in a number of disciplines and fields. A considerable body of knowledge has resulted from extensive research through the years in the area of behavioral sciences. Learning theories and principles, identification and classification of human behavior, performance measurement and evaluation are some of its contributions. From the educational field have come advances in test construction, development of instructional media and pedagogical techniques, and empirical application and assessment of behavioral principles, among others. The field of management has added to ISD development by providing techniques such as job analysis and occupational surveys, communication, motivation and attitude studies, and criteria development.

Within the above spheres of influence there are two interrelated factors which perhaps more than any others can claim major responsibility for the refinement and fruition of the ISD approach used today. They are the evolution of programmed instruction and the explosive expansion in computer technology and application.

The entrance of teaching machines, scrambled books, and the like, upon the educational scene in the late fifties and early sixties, although falling short of its heralding as a "revolutionary new approach to teaching," nevertheless did represent considerable effort in the beginnings of programmed instruction. Concepts and techniques of linear and branching programs required close attention to the precise, explicit formulation of the tasks to be trained and training objectives, and to the presentation of instructional materials. With concomitant development of instructional delivery systems (sound/slide, CRT, etc.), individualized, custom-tailored training became feasible; a viable alternative to traditional, uniform, classroom instruction.

As is often the case, improvement or progress in one area, creates new or additional burdens elsewhere. Making use of this newly developed flexibility in training programs placed enormous demands for data gathering and recording, formerly the responsibility of the instructors, but which could now be readily transferred to computers. Scheduling of resources and facilities for training, monitoring of progress of students through the program, recording test materials and results, and gathering and storing data to permit evaluation of student performance, as well as assessment of the training program itself is readily and economically accomplished with the computer.

With this development in techniques for precise definition of training objectives and the instructional material content and form to achieve the objectives, combined with a capability for scheduling, monitoring, recording and processing, the ISD approach can be applied to any training situation.

SYSTEM DESCRIPTION

AIRCRAFT. The A-6E TRAM aircraft is a two-man subsonic, mid-wing attack aircraft, with side-by-side seating for the pilot and bombardier/navigator (B/N). Designed and manufactured by Grumman Aerospace Corp., Bethpage, L.I., N.Y., A-6E TRAM is a true-all-weather attack aircraft that can carry a payload of 8.5 tons. A wide variety of weapons can be delivered without the crew ever seeing the ground or target.

The aircraft is powered by two Pratt & Whitney turbojet engines and is characterized by a large nose radome and swept-back wings. It has arrested landing capabilities and a relatively slow approach and landing speed for a jet aircraft. It can be air refueled as well as being used as a tanker. A single-point ground refueling capability shortens turnaround time and eases normal refueling. Automatic isolation of less-important electrical loads, redundant hydraulic power systems, and tandem actuators minimize the chance of complete loss of essential functions due to battle damage or system malfunctions.

TRAM (Target Recognition, Attack, Multisensor) configured, the A-6E aircraft has a completely integrated computer navigation and aircraft control system, radar, armament, flight sensors, and cockpit displays which permits all-weather operation under varying tactical requirements. The integration of these systems results in an aircraft with the versatility to perform not only as an attack bomber, but also in close support of ground personnel.

The major features of the A-6E TRAM configuration include:

a. Ballistics Computer Set AN/ASQ-155 – a stored program digital computer with increased capability. This computer is the center of the integrated weapons system, providing flight data, navigation and control commands, target tracking, attack and various inputs needed for proper arming, fuzing and release of selected stores.

b. Carrier Aircraft Inertial Navigation System (CAINS) – an increased accuracy navigational system.

c. Detecting and Ranging Set (DRS) – providing enhanced target identification and recognition capability via a forward-looking infrared receiver (FLIR) and laser rangefinder and receiver, DRS control panel and FLIR display imagery. The DRS also includes a BIT test.

d. Armament Control Unit (ACU) – modified to permit safe arming and release of expanded selected ordnance.

e. Modified Communications Navigation and Instrumentation System (CNI).

f. Automatic Flight Control System (AFCS) – providing three-axis stability augmentation attitude control and automatic flight path control of the aircraft.

g. All-Weather Carrier Landing System (ACLS) – providing automatic touchdown capability for carrier aircraft. Commands generated by shipboard computers enable aircraft AFCS commands, providing safe, reliable final approach and landing during daylight or darkness, with minimum interference from conditions of severe weather and sea state and no limitation from low ceilings or visibility. System provides three modes of operation differing in the extent of automation.

h. Modification to accept Condor missile includes control units, mounting, cabling and display inputs.

MISSION. The mission of the A-6 Intruder is to perform high and low altitude all-weather attacks. These attacks might be conducted as close air support for ground forces, or as short- or long-range interdiction raids (for example, against installations or roads). The A-6E TRAM aircraft, while not adding any new missions, significantly improves weapons system delivery capability. Because the A-6 is capable of performing just about every type VFR and IFR attack mission, its stores are varied. It can deliver a large selection of conventional and nuclear weapons, bombs, rockets, guns and missiles, as appropriate, to a multitude of air and surface targets. Bombs, rockets and missiles can be released in either a manual or automated mode, whereas guns are manually fired. The aircraft is provided with a number of delivery techniques, controlled by the aircrew, or which, at crew discretion, can be fully automated. If system degradation or tactical requirements demand, the aircraft can be used as a VFR bomber.

Although specific TRAM tactics have not yet been developed, missions for which the A-6E TRAM aircraft might be deployed are outlined as follows:

- Fixed land target attack
- Route reconnaissance
- Ship attack
- Mine laying
- Trails and roads interdiction

Associated mission functions, including ECM detection, can also be performed by the aircraft. Air combat maneuvering is generally limited to escape techniques. The aircraft is not designed, nor equipped, for use as a fighter aircraft. It has air-to-air missile defense capability. An AMTI (Airborne Moving Target Indication) feature of the A-6E allows detection of moving targets in all weather, day or night, and attack with the weapon system.

Fixed Land Target Attack. Attack missions of this type include bridges, buildings or other similar installations. Available intelligence information such as photographs or video tapes of the target and target area, maps, location and type of target and expected defenses, permits appropriate planning for approach to target, weapon selection and delivery techniques and escape maneuvers. FLIR capability enhances identification of terrain features known to be IR sensitive, e.g., water/land boundaries, as well as target features, e.g., full tanks vs. empty in a fuel storage depot. Acquisition of targets in

complexes (e.g., one building in a cluster) requires good area orientation, photos and other aids. Attack might be performed with a low altitude, terrain following approach. Variety of weapon fuzing, time delays and spacing is available according to the particular target.

Route Reconnaissance. This type mission involves A-6 patrol or armed reconnaissance of a predetermined highway, trail, etc. Targets sighted within this area of operation could be sighted, tracked and reported on and an attack initiated according to rules of engagement. Trucks, convoys, tanks and troops are typical of the targets to be encountered. A forward air controller capability also allows other plane or even ground laser designated targets to be attacked.

Ship Attack. Ship attack might be performed by a single aircraft or by an alpha (multiple aircraft) strike. Both radar and FLIR are available for target acquisition and classification and heading determination. Laser capability can be used to improve performance. Approach delivery mode and escape maneuver would vary according to ships defense, design, etc.

Mine Laying. Mine laying missions can be of three kinds: (1) laying explosive-loaded mines for combat roles; (2) laying actuation dummies, for use in mine sweeping drills and evaluation; and (3) laying dummies, used in mine planting exercises.

Placement of mines is determined by the strategic and tactical goals of the mission. A-6E aircraft have advantage over surface and subsurface mine laying in that they can plant mines in previously mined areas. High speed and freedom of maneuvering of the aircraft also provides an element of surprise. Conversely, a disadvantage is the smaller carrying capability of the aircraft. A number of onboard systems can be used for mine laying.

Trails and Roads Interdiction. This mission might be considered a type of fixed-target attack mission, with a particular strategy of prevention of use of the trail or road for movement of enemy troops or equipment.

TRAINING PROGRAM. The East Coast A-6 Readiness Squadron, VA-42, is currently conducting transition training for four categories of pilots and two categories of bombardier/navigators. A summary of these categories and of the major training elements associated with them are provided in Tables 1 and 2. Both pilot and B/N training programs are divided into discrete phases consisting of: ground school activities such as lectures and demonstrations, simulator exercises, and A/C flights. The major activities associated with each phase of training for the category 1 (first tour in A-6) pilot and B/N are described as follows.

PILOT PHASES

Familiarization Phase. The replacement pilots (RP) are paired with an instructor pilot (IP) on all flights except two, on which an instructor bombardier/navigator (IBN) may be substituted. These flights involve a complete checkout in the aircraft under day VFR conditions. Included in these flights are aerobatics, formation flying and precision approaches in addition to practice landings in all configurations. Two of the nine familiarization flights are flown at night.

Visual Weapons Phase. Replacement pilots receive fourteen flights. These flights acquaint the replacement with manual deliveries associated with various conventional weapons. Emphasis is placed on the replacements obtaining a qualifying dive bomb 50-ft CE (circular error). Three of the flights are Close Air Support (CAS) and simulated ALPHA strikes. The CAS flight utilizes maximum available live ordnance under Forward Air Control (FAC), and the ALPHA strikes simulate current strike procedures with heavy ordnance loads. All flights proceed to and from the targets in formation utilizing tactical maneuvers.

TABLE 1. VA-42 A-6 READINESS PILOT TRAINING SUMMARY[(a)]

Category		Number of training flights		Flight hours		WST hours	Ground training lectures,[(b)] hours	Total syllabus, weeks
		A-6	TC-4C	A-6	TC4C			
(1)	First tour in model	65	2	102.5	6.5	12.5	192.3	27
(II)	Second tour in model	49	0	69.5	0	12.5	146.3	22
(II)	Model training for commander and staff of carrier air group	36	0	51.5	0	9.0	102.8	17
(IV)	Ferry pilots	4	0	10.0	0	4.5	24.0	5

TABLE 2. VA-42 A-6 READINESS BOMBARDIER/NAVIGATOR TRAINING SUMMARY[(a)]

Category		Number of training flights		Flight hours		WST hours	Ground training lectures,[(b)] hours	Total syllabus, weeks
		A-6	TC-4C	A-6	TC-4C			
(I)	First tour in model	32	10	61.5	35.0	14.5	216.5	27
(II)	Second tour in model	17	3	31.0	11.0	4.5	140.5	19

[(a)]Data is based on latest schedules provided by VA-42 SMEs.

[(b)]Ground Training figures do not include courses listed as "Navy Formal School Training," e.g., Fire Fighting School.

Navigation Phase. Replacement pilots receive five navigation flights which include two Dead-Reckoning (DR) flights, two system navigation flights, and one TC-4C system navigation flight. During the DR flights, the pilot acquires sound dead-reckoning techniques and learns to identify visual check points while flying at low altitude and high air speeds. System navigation flights introduce replacement pilots to radar navigation, radar scope interpretation, system navigation equipment capabilities and techniques, and the terrain following feature of the A-6E. The TC-4C flight involves the replacement pilot operating the A-6E system, utilizing those pilot's displays which are available.

Tactics Phase. Replacement pilots are introduced to and practice offensive and defensive air combat maneuvers, and day and night air-to-air refueling. Replacements learn to fly the aircraft to maximum performance parameters in air combat maneuvering within the operational envelope of the aircraft.

System Weapons Phase. This phase consists of nine flights which introduce the replacements to all-weather attack training and capabilities of the A-6E. They learn to interpret the vertical display indicator (VDI) in precise detail and practice combat breakaway maneuvers from defended targets. The replacements become capable of using all attack modes in the A-6E delivery system.

Carrier Qualification Phase. This phase prepares replacements pilots for initial A-6 carrier qualification, both day and night, and familiarizes replacement bombardier/navigators with carrier operations. During day-flights of field carrier landing practice (FCLP), replacement pilots are trained to fly the FCLP pattern under simulated night, reduced visibility conditions. Sound, smooth corrections are emphasized. The carrier qualification portion consists of ten, day arrested landings and six, night arrested landings which replacement pilots must satisfactorily complete in order to qualify. Replacement bombardier/navigators are introduced to the day and night carrier landing environment.

BOMBARDIER/NAVIGATOR PHASES

Familiarization Phase. Replacement bombardier/navigators (RBN) are acquainted with the aircraft flight characteristics, the local operating area, preflight procedures, cockpit procedures and air-to-ground communication procedures used in the A-6.

Navigation Phase. In the navigation phase, replacement bombardier/navigators are taught dead-reckoning (DR) navigation procedures, route planning, radar and computer fundamentals. They are given instruction in search and doppler radar, inertial navigation system, computer, air data computer, and AMTI circuitry which are the primary components of A-6 attack/navigation system. Replacements fly 11 navigation flights: five in the TC-4C, six in the A-6.

Radar Target Identification Phase. This phase, an extension of the theories and practices learned in the navigation phase, acquaints the replacement bombardier/navigator with precise target acquisition and following, terminating in a simulated attack. Replacements fly three flights in the TC-4C with instructor B/Ns and five flights in the A-6 with instructor pilots. The flight envelope ranges from high altitude/low speed (7000-ft MSL/270 kt) to low altitude/high speed (1000-ft AGL/360 kt).

System Weapons Phase. This phase acquaints replacement bombardier/navigators with all modes and methods of delivering conventional and nuclear ordnance using the A-6 weapons system. Replacements fly 15 flights in this phase which consist of bombing, mining, AMTI, and radar target identification (RTI). RTI is the most demanding type of bombing for the replacement and requires a maximum of preflight planning. This phase polishes the professional skill of replacement in utilizing their weapon system by making repeated attacks against ranges and complex targets.

Carrier Qualification Phase. Replacement bombardier/navigators fly with replacement pilots during FCLP sorties and initial carrier qualification (both day and night). Although this is required as a part of the replacement bombardier/navigators syllabus, training is accountable to the replacement pilot.

Visual Weapons and Tactics. Replacement bombardier/navigators syllabus, training is tachment during their training to fly with replacement pilots for visual bombing. Tactics flights are flown with instructor pilots.

SECTION II

OVERVIEW

ASSUMPTIONS AND CONSTRAINTS

Phase I of this ISD project was devoted to the design of an A-6E TRAM aircrew training program. Within the scope of this effort a number of assumptions were made and constraints applied throughout the conduct of the work. These are identified and briefly discussed below.

a. VA-42 was designated Squadron Model Manager for the program. All Navy personnel participation including Subject Matter Experts (SME) was to be coordinated through that squadron.

b. The training program being developed was to be limited to the Readiness Squadron portion of pilot and B/N training. No effort was to be expended in determining training requirements, media recommendations, etc., for basic flight training in the Air Training Command (ATC), operational squadrons, or with the combined requirements of readiness and operational squadrons sharing common base facilities.

c. When the job descriptions were completed, no attempt was to be made by the Navy/contractor ISD team to evaluate the appropriateness of the location at which training for those activities was being conducted. The SMEs identified those activities which were taught in the ATC phase and which therefore could be considered as Readiness Squadron entry level behavior. They also indicated those which were being trained in the Readiness Squadron and those which were under the jurisdiction of the operational squadron. Only those activities for which there was some Readiness Squadron involvement (either being introduced or practiced therein) were addressed and subjected to the ISD process.

d. The numbers of pilots and B/N's assigned to and arriving at the Readiness Squadron at any one time were such that a resulting class size would be less than 10 or 12 individuals. Nonvalidity of this assumption could impact the recommendations made for media utilization. For example, demonstrations using the WST might have been accomplished with different media if class size was greater than 20.

e. During the time the replacement pilot and B/N are assigned to the Readiness Squadron, they take a number of formal Navy school courses. These courses are not uniquely part of A-6E training but are common to all NFOs. They include courses such as Intelligence Training and Aviation Physiology Training (ejection seat and pressure chamber); Water Survival Training; and Survival, Evasion, Resistance and Escape (SERE). These were not to be addressed as part of the ISD process, but must be considered when preparing a syllabus. Those formal courses which are A-6 oriented, (e.g., Naval Air Maintenance Training and Conventional Weapons School) were addressed.

   In addition, with the concurrence of the SMEs, all task activities involving secret security classifications (such as in the EW, ECM and nuclear areas) were not addressed. The attempt was made to describe the remaining activities of the pilot and B/N in such a manner as to permit the lowest security classification possible while still meeting the requirements of the process. As a result, only the task listing of B/N activities and the treatment of aircraft tactics required confidential classification. These are included in the same document[1]. All other documentation produced during Phase I was unclassified.

f. The scope of this Phase I contract required the application of the ISD process through the development of Lesson Specifications, but excluded the integration of the lessons into a total syllabus of training for the replacement pilot and S/N.

g. Four types of pilot personnel receive training in the A-6 Readiness Squadron

   (1) First tour aviator (first tour in model)

   (2) Second tour pilot (return from fleet assignment)

   (3) Commander (training/briefing on A-6E capability)

   (4) Ferry

h. Two types of B/N personnel receive training in the A-6 Readiness Squadron

   (1) First tour B/N (first tour in model)

   (2) Second tour B/N

The ISD process was applied to the design and development of a training program for the first tour pilots and B/Ns, the least knowledgeable with regard to A-6 operations of all the forementioned types. This type airman is also the most representative of the types entering the Readiness Squadron. In comparison, the first tour airman brings to the squadron relatively minimal entry level skills and knowledges, and therefore requires the broadest scope and most comprehensive training program. Other pilot or B/N types require some lesser amounts of training, which can be stylized in accordance with their particular skills and training requirements.

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[1] J. Hanish, Task Listing, A-6E (TRAM) Aircraft, Bombardier/Navigator Procedures, Vol. II, Grumman Aerospace Corp., Bethpage, N.Y., Report ISD (SAT) 0003-2, Sept. 1975.

APPROACH

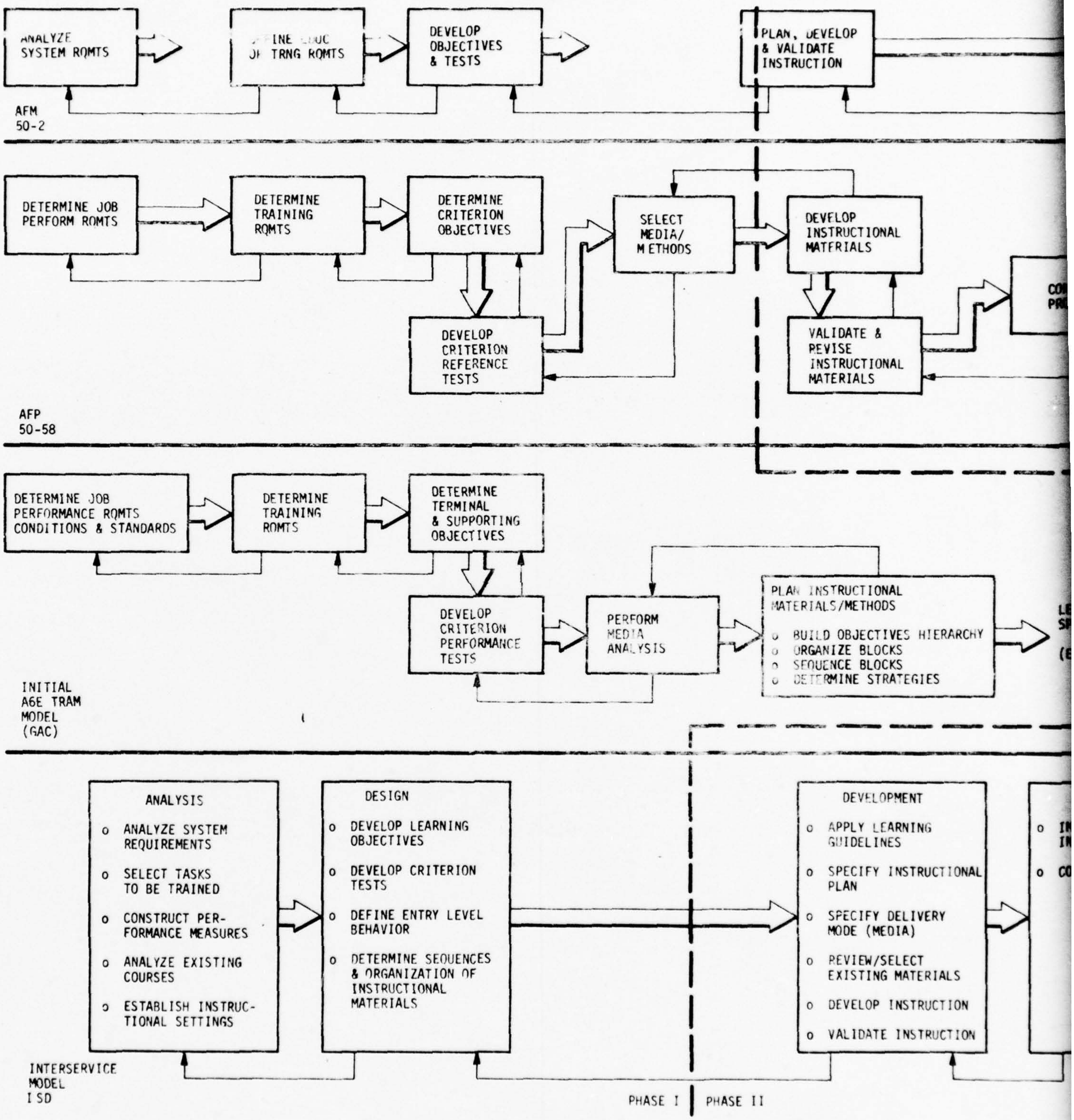
According to how they group and identify activities, most proponents of the use of the ISD approach are in general agreement that there are 5 to 9 major and distinct activities included in the process. Figure 1 provides a block diagram representation of the major ISD activities as identified in: (a) Air Force Manual 50-2, Instructional System Development; (b) the five-volume Handbook for Designers of Instructional Systems, AFP 50-58; (c) the recently published TRADOC PAMPHLET 350-30, Interservice Procedures for Instructional Systems Development, a comprehensive description of approved procedures and techniques to be followed in development and conduct of interservice training; and finally (d) the Grumman report, The Development of a Systems Approach to Training and Its Application to A-6E TRAM .....Aircrew Training. [1]

The approach Grumman followed in the Phase I design of the A-6E TRAM training program was in close accord with AFP 50-58. It consists of performance of the first five of the following activities, which we consider as adequately representative of the ISD process.

IDENTIFICATION OF JOB PERFORMANCE REQUIREMENTS. The first step in the process, and a most critical one, is to define and describe the tasks that must be performed by the A-6E pilot and B/N when they are in the operational environment. The tasks must be comprehensive and stated in sufficient detail so as to enable the identification of all the knowledges and skills that are involved in their successful completion. Further, it is also necessary in this step to describe the operational conditions, within which these jobs/tasks are performed in order to properly assess their impact on, or interaction with performance. Finally, appropriate criteria or standards which, when achieved, represent acceptable behavior or performance of the job, must be identified and agreed upon. (The problem of criteria identification, one of the more difficult problems encountered in applying the ISD process is discussed more fully in the Rationale portion of this section). Since the training program development depends heavily on a good job performance analysis, the criticality of this first step becomes evident. However, because it is an iterative process, some omission or errors can be corrected downstream. Job performance activities and requirements were identified through a joint team effort conducted by contractor ISD training specialists and VA-42 SMEs (subject matter experts). In its role as model manager for the program, VA-42 assigned combat experienced pilots and B/N's, who were also veteran instructors, to provide technical support, monitoring and guidance as required throughout the various activities of the program. The division of work betweem the Navy SMEs and the Grumman specialist will be discussed shortly.

DETERMINING TRAINING REQUIREMENTS. Not all the tasks that collectively define the jobs the replacement pilot and B/N will perform in the operational environment need to be trained. Some of the simpler motor actions may already be in their repertoire. Others may already have been trained during basic flight training. Still others may be more appropriately introduced and/or practiced after assignment to an operational squadron. This second major activity of the ISD process is directed toward identifying what changes in knowledges, skills and attitudes of the pilots and B/N's entering the Readiness Squadron are required to enable them to perform their identified jobs. This activity varies in magnitude depending on the variety or homogeneity of the incoming trainee group with respect to basic training or entry level skills, and the availability of this data. When such data is not readily available, screening or entry level testing may be required.

[1] Campbell, S., Egan J., Morganlander, M., and Schaefer, R. "Proposal for the Development of a Systems Approach to Training and Its Application to A-6E (TRAM), ...Aircrew Training", Grumman Aerospace Corp., Bethpage, N.Y., Feb. 1975.



ANALYZE SYSTEM RQMTS
TRNG RQMTS
DEVELOP OBJECTIVES & TESTS
PLAN, DEVELOP & VALIDATE INSTRUCTION
AFM 50-2
DETERMINE JOB PERFORM RQMTS
DETERMINE TRAINING RQMTS
DETERMINE CRITERION OBJECTIVES
SELECT MEDIA/ METHODS
DEVELOP INSTRUCTIONAL MATERIALS
DEVELOP CRITERION REFERENCE TESTS
VALIDATE & REVISE INSTRUCTIONAL MATERIALS
AFP 50-58
DETERMINE JOB PERFORMANCE RQMTS CONDITIONS & STANDARDS
DETERMINE TRAINING RQMTS
DETERMINE TERMINAL & SUPPORTING OBJECTIVES
DEVELOP CRITERION PERFORMANCE TESTS
PERFORM MEDIA ANALYSIS
PLAN INSTRUCTIONAL MATERIALS/METHODS
o BUILD OBJECTIVES HIERARCHY
o ORGANIZE BLOCKS
o SEQUENCE BLOCKS
o DETERMINE STRATEGIES
INITIAL A6E TRAM MODEL (GAC)
ANALYSIS
o ANALYZE SYSTEM REQUIREMENTS
o SELECT TASKS TO BE TRAINED
o CONSTRUCT PERFORMANCE MEASURES
o ANALYZE EXISTING COURSES
o ESTABLISH INSTRUCTIONAL SETTINGS
DESIGN
o DEVELOP LEARNING OBJECTIVES
o DEVELOP CRITERION TESTS
o DEFINE ENTRY LEVEL BEHAVIOR
o DETERMINE SEQUENCES & ORGANIZATION OF INSTRUCTIONAL MATERIALS
DEVELOPMENT
o APPLY LEARNING GUIDELINES
o SPECIFY INSTRUCTIONAL PLAN
o SPECIFY DELIVERY MODE (MEDIA)
o REVIEW/SELECT EXISTING MATERIALS
o DEVELOP INSTRUCTION
o VALIDATE INSTRUCTION
INTERSERVICE MODEL ISD
PHASE I
PHASE II

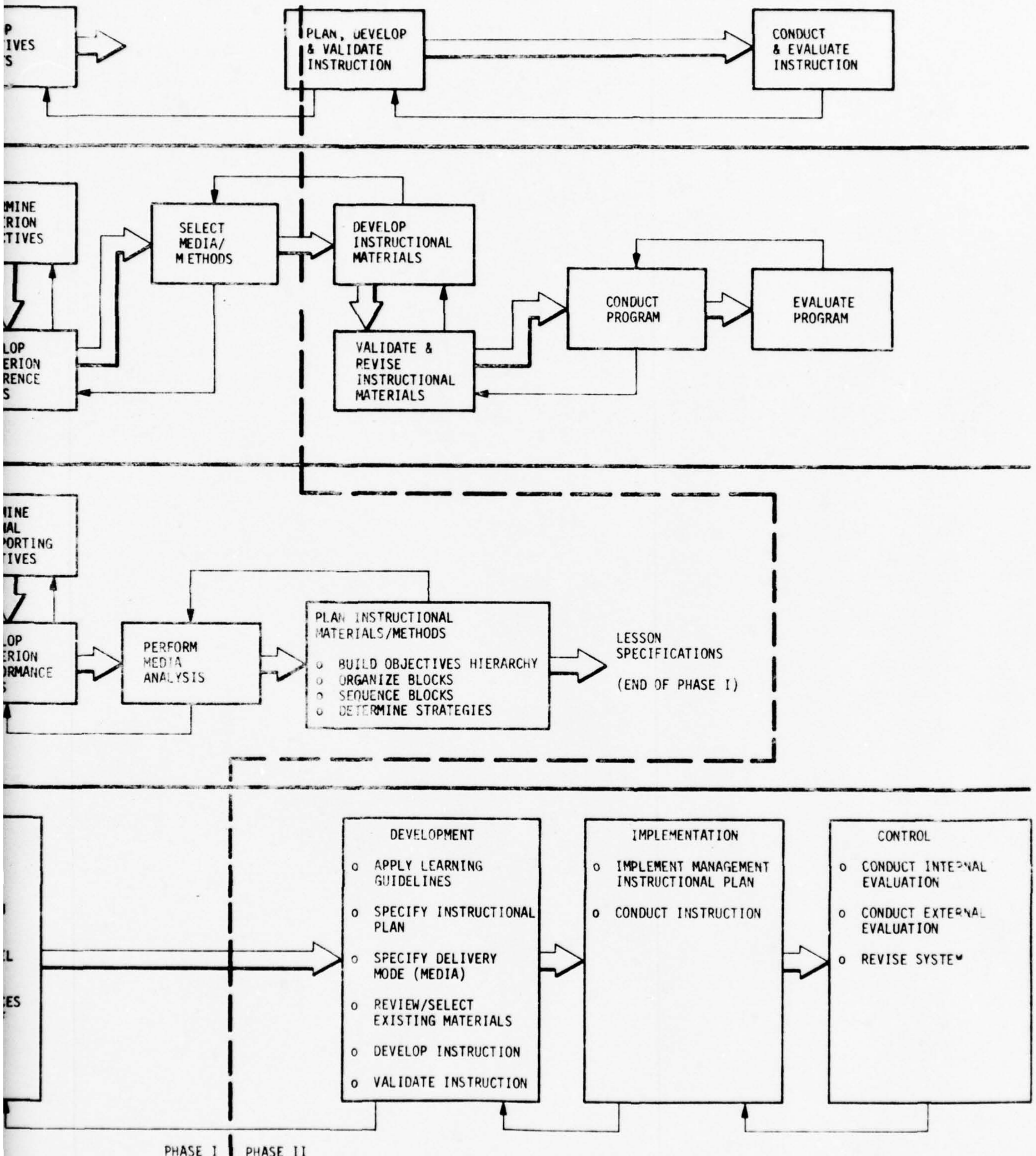


Figure 1. ISD Models

A second consideration which affects the size of the effort in determining tasks to be trained is the extent of resources available. Reality always "intrudes" to place limits on how many resources can be allocated to training. These constraints might for example take the form of limited dollars and/or equipment, limited instructor availability, limited time to conduct training, or some other factors. Rarely is there sufficient time or equipment to train all the tasks that should be trained to the criterion level desired. Depending upon the specific constraints concerned, priorities can readily be placed on the selection of tasks to be trained, or the time allotted to criterion achievement. Such factors as time criticality of the task, its frequency of occurrence, and the likely consequences of inadequate performances can be used to set up a hierarchy classification for tasks to be trained.

DETERMINE CRITERION OBJECTIVES. The term criterion objective is often used interchangeably with terminal learning objective, and is meant to identify the learning and behaviors which are demonstrated, or inferred from demonstrable behavior, upon completion of the training program. The first task of this phase therefore is to identify all those behaviors which, when performed at or beyond a pre-determined minimum criterion level, will indicate that the training program has achieved its goals. These behaviors will closely resemble, if not be identical to, that behavior which will be exhibited in the operational environment. Its demonstration is prima facie evidence that the required behavior is within the individual's repertoire.

In addition to the behavior statement, however, a standard or criterion or performance for that terminal behavior must also be established. The standard generally should be at a level comparable to the earlier established operational standards. These latter criteria however, while reflecting an acceptable level of behavior must also be consistently attainable. In other words, the same acceptable level of performance must be attained for numerous repetitions of a given behavior. In the training situation, to achieve a level of confidence that the desired behavior will be realized operationally some feature of repeatability may be added to the training standard, e.g., ". . . . in 6 of 7 trials the pilot will . . . . ," or ". . . . the B/N, after the third flight, will perform without error the . . . ."

Alternatively, a more demanding, severe standard might be required. For example, assume a 10-foot CEP has been established as the standard of acceptable operational behavior. Because it may be impractical or uneconomical to require demonstration of repeatability of performance, e.g., 8 flights, capability for acceptable behavior might be inferred if the trainee achieved a CEP of 6 feet or less on 4 successive flights. Extreme caution should be exercised before this type of standard is included. A number of potential pitfalls await its indiscriminate use. For example, system delivery errors may place a severe burden on crew performance, making demands far in excess of reasonable performance expectations. Failure to achieve criterion level performance, or inordinate amounts of practice would likely result from this situation. Also, it might be entirely impractical to expect operational level performance from Readiness pilots. This level might not attained until considerable additional training is received in the operational squadron.

A third part of this task is to identify the conditions under which the job performance will be exhibited or inferred. These conditions can be of two kinds. They may represent significant aspects of the operational environment which should be simulated or replicated in the training situation, because they may have an appreciable effect on performance. Day or night navigation flights, carrier or field landings, fully operational

or malfunctioning aircraft or weapons systems are examples of this type of condition. The second kind of condition refers to the aids or prerequisite data available to the crewman when he is called upon to demonstrate criterion level behavior. The use of checklists, radar scope photography, on-board nomographs and the like represent this type condition.

The terminal behaviors can be classified into various types. The simplest classification providing a useful subdivision is four fold: knowledges, mental skills, physical skills and attitudes. Once typed, the behaviors need to be further analyzed for prerequisites, that is, enabling skills and knowledges which must be mastered before training to ensure that terminal objectives can be completed. Prerequisite skills and knowledge requirements theoretically should continue to be extracted until the judgement can be made that all materials actually required in the learning process are identified and further extraction is not required, either because as the trainee already possesses the knowledge and skill identified, or additional material would be superfluous to the terminal objective. Obviously there are constraints and limitations in developing the training program just as there are in conducting the program. A practical limit is always set on the evolution of enabling objectives.

The identification of the totality of learning objectives that must be satisfied, terminal and enabling alike, provide necessary control over the course content of the program. Unnecessary or irrelevant instruction both in on-going programs or in programs under development can be eliminated or avoided. Their very specificity further enables the trainee to have a clear, exact understanding of what is and will be expected of him. All his effort can be properly channeled to development of necessary skills, knowledges and attitudes. Spurious information attainment or extraneous practice can be avoided.

DETERMINE CRITERION REFERENCE TESTS. This activity is concerned with developing test statements which will be direct measures of the criterion level behavior. Tests usually are written for each of the learning objectives, measuring as precisely as possible the behavior induced as an outcome of the instruction. Tests should sample behavior at the same level of detail as presented and practiced in the learning situation. Where the total behavior cannot be adequately demonstrated in test, or when it is impractical to do so, the tests should at least include sufficient sampling of the instructional elements and behavior so as to provide confidence in the adequate mastery of all the material.

On occasion, a test constructed to measure satisfaction of a terminal learning objective can also simultaneously satisfy a number of associated enabling objectives. In these situations, successful test demonstrations imply possession of the prerequisite knowledges and skills.

It is recognized that, when relatively complex performance measurement is involved, as in the case of a pilot and B/N flying an A-6E TRAM aircraft on an attack mission, reliable and valid measures are not only difficult to obtain, but are often relatively low in a statistical sense. Nonetheless, they are the key to making the necessary decisions about the operational readiness of the student as well as the assessment of the quality and content of the instruction itself.

The test standards, recognizing the build-up of skill levels, are generally less demanding early in the training sequence. Final performance should usually reflect the standards required in the operational situation.

SELECTION OF INSTRUCTION METHODS AND MEDIA. This activity is concerned with the organization of the training objectives into meaningful instructional units, the analysis and selection of appropriate training media to support the instruction and the initial selection of instructional strategies intended for implementation in the units.

Once the tasks to be trained have been identified and the learning objectives specified, consideration needs to be given to decisions about how the tasks ought to be trained. These include the grouping of materials by logical relationships. Also, determining what information should be offered as prerequisite to other materials. Media considerations include how best to use media to provide effective and efficient training. What media are appropriate for what instructional units? What media are available or need to be developed? The organization of instruction also requires a determination as to what kinds of instructional settings are most appropriate for the conduct of training. Should the training be self-taught, self-paced, or individualized? Should it be conducted in a more formal setting as classroom or trainer? Should it emphasize on the job training, i.e., with the aircraft on the line or in-flight? Is the training appropriate for inclusion in the Readiness Squadron curriculum or should it be conducted by a support organization or in the operational squadron?

A number of factors enter into the making of appropriate decisions. These include the skill levels of the personnel to be trained, the resources and facilities available, the number of personnel entering the squadron, the number of training activities that need to be integrated with other Navy units outside the Readiness facility, e.g., carrier qualifications, and visual weapons deployment, and finally, the skill with which appropriate learning guidelines and principles are selectively applied to the instructional unit organization.

A number of principles proven effective across all types of learning situations can be applied generally. These include, for example, principles of feedback application, the use of practice, prompting and cueing and hand-on training. Other principles are more appropriate for one kind of learning behavior than another. For example, learning may involve grasp of a concept, in which case a number of illustrative examples may be presented, but when once understood, further practice is not required. Conversely, if a manipulative skill is to be achieved, continued practice might be required to keep the skill at a desired level. [1]

Final selection of learning guidelines, principles and instructional strategies is accomplished during the development phase of the program when each of the lessons of the curriculum and the instructional materials are produced.

Where a training program with associated media already exists, it is appropriate to review the syllabus and curriculum to determine how much of it satisfies the ISD training objectives, and how much of the material is potentially useful. This process should, however, be conducted in consort with the instructor staff, to assure that what appears to be identical in name, is identical in content. Too often, like-sounding subjects, lessons or

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1 For a more detailed listing of learning principles and guidelines applied to training see TRADOC Pamphlet 350-30; Phase III Development, Interservice Procedures for Instructional Systems Development, 8/75. Also, Willis, M.P and Peterson, R.O., Deriving Training Device Implications from Learning Theory Principles, American Institute for Research, Pittsburgh, Pa, Report NAVTRADEVCEN 784 -1, 2 and 3, July 1961.

other instructional materials contain information or data which would be considered as superfluous or unjustified by the ISD process, or which would have the wrong emphases. Where the curriculum materials do satisfy ISD training objectives, some measure of instructional material validation can likely be obtained.

At the same time the curriculum is being reviewed, it is also appropriate to survey or otherwise analyze the supporting media available in inventory. While final media selection awaits results of instructional materials organization and sequencing, as well as instructional strategies employed, a preliminary feel as to what is available, or what might need to be purchased commerically is valuable to the program developer. By sorting the behavioral objectives in terms of the capability for satisfaction by generic media type, early consideration can be given to the type and eventual number of hardware units that are likely to be required. In addition, important instructional features within the learning objectives are often identified.

DEVELOPMENT OF INSTRUCTIONAL MATERIALS. This activity consists of the actual production and integration of the instructional material which will be used in the training program, e.g., sound-slide programs, charts, curricula. It and all subsequent major ISD activities are to be performed during Phase II.

VALIDATION AND REVISION OF THE INSTRUCTIONAL MATERIALS. This effort has three goals: (1) to ensure the technical adequacy and correctness of the instructional materials produced; (2) to obtain preliminary concurrence and evidence that the proposed training is appropriate for achieving the training objectives; (3) to verify that the desired learning is indeed the result of training with the instructional materials.

The validation process usually consists of a series of trials, first with a few subject matter experts, followed by small group and large group trials. The first trial usually is directed toward goal 1 while the latter trials are intended to achieve goals 2 and 3. The subject personnel for the latter trials are sample group representations of the trainee population. Often pre- and post-tests need to be prepared as measures of performance improvement resulting from training with the instructional materials. Revisions to this material can be made after each of the three trials, and should be completed before the production run on the instructional matter.

CONDUCT OF THE TRAINING PROGRAM. This task consists of the actual scheduling and implementation of the training program. In addition to the presentation of the curriculum materials, it will include instructor preparation and training in the use of instructional materials and the daily scheduling of personnel, instructors, facilities and training resources. An important part of this activity is the identification of and the planning for acquiring of field data to evaluate the on-going program.

EVALUATION OF THE INSTRUCTIONAL PROGRAM. Once the instructional program has been completed an assessment of how well that program prepared the trainee group to perform in the operational situation needs to be made. Detailed performance records which can be compared with training requirements and standards need to be collected. These records often need to be supplemented by surveys made in the operational squadrons, to complete the training program assessment and to ensure accurate interpretation of the performance records obtained.

RATIONALE FOR METHODOLOGY USED

The ISD methodology followed in designing the A-6E TRAM aircrew training program was, in general, that described in the preceding section. However, there were a few problems involved and decisions made about the approach which warrant further clarification. These were:

- The role of the SME in the ISD process
- Media recommendations and the Lesson Specification
- Identification and use of performance standards

THE ROLE OF THE SME IN THE ISD PROCESS. Considerable thought was given as to how one might best use the time and expertise of the SMEs in the ISD process. Mindful of the fact that the SME is at the same time one of the instructors who will eventually be conducting the training, the impulsive approach might attempt to involve the SME as much as possible, even to the extent of making him an ISD "expert". While this approach has the obvious benefit of having the instructor prepare his own training program, it suffers from some major flaws.

First, it places a restriction on the selection of SMEs. A considerable amount of time would have to be invested in initiating the SMEs to the ISD philosophy and in training them to conduct the process. This investment would dictate that the SME continue the process to completion. Rotation and reassignment of SMEs due to completion of tour of duty would result in costly retraining to bring the new SMEs "up to speed". Secondly, because both instruction in the ISD process and production of the training program via this approach is a relatively time consuming process, the SME who performs the ISD becomes almost totally lost to the squadron for other duties during the entire time required for the program design phase (Phase I), and likely much of the time during the development phase (Phase II).

Thirdly, the very nature of the ISD process tends to become a real problem, highly attitudinal in nature, for the SME. Performing the ISD requires a detailed, painstaking attention to behavioral activities, often at a most elemental level. The process is thorough, logical and complete, but tedious and laborious. In fact, it is considered by some as ofttimes boring in its day-by-day activity. The SME on the other hand is an experienced, successful Naval Flying Officer. By aptitude as well as by interests, if not almost by definition, he is an intelligent, dynamic and highly motivated individual, who greatly prefers doing, which in this case is spelled f-l-y-i-n-g, to sitting at a desk preparing behavioral objectives. He has not been selected and trained at considerable cost to the government to spend his time as an educational specialist, at possibly considerable cost to himself.

At the opposite end of the spectrum of SME involvement, one might attempt to minimize any interference with the SME squadron duties, limiting his participation to consultation on technical matters, and review of program design material developed by the contractor training specialists. The principal danger of this approach is that the task analysis and resulting training materials will lack the operational flavor and subtle essentials that can only be recognized and appreciated by the professional. Just as it seems inappropriate to require the SME to be an ISD specialist, so too, it is equally inappropriate for the training specialist to attempt to achieve a level of technical competence sufficient to

perform a satisfactory analysis of the operational activities of the flight crew. Because the ISD success or failure is heavily dependent upon the validity and completeness of the first major step, the job analysis, the SME must be sufficiently involved to ensure that the training specialist has an adequate understanding of these activities.

A secondary danger, likely to be encountered if the training expert conducts ISD in isolation from the SME and other squadron personnel, is that the failure of the contractor training specialist to communicate adequately to these key personnel the intent of the ISD process, could result in a suspicion of the validity and merit of the instructional material.

Grumman opted to recommend SME participation somewhat between these two approaches. Heavy participation was requested of VA-42 SME personnel during the job analysis. Grumman ISD specialists and Navy SMEs worked together as a team alternately on-site at VA-42 and at the contractor's facilities until comprehensive, although preliminary mission oriented nominal, malfunction and emergency pilot and B/N task descriptions were identified. At that point participation from VA-128 personnel was enlisted. The VA-128 SMEs provided a validation of the preliminary task listings. Only minor modifications were required to achieve mutual squadron agreement.

Because the SME role was that of the technical/operational expert, two changes in SME assignments were accomplished without perturbing the process. The first occurred in VA-42 tour of duty reassignments of both the pilot and B/N SMEs during task listing development. The transitional phase was accomplished smoothly. The second change was in assignment of pilot support from VA-128. Short-term assignment during the validation of the task listings and during the identification of performance standards and operational conditions did not cause undue delay as SMEs were not called upon to perform in areas outside their expertise.

SMEs also provided liaison in surveying media available within their respective squadrons and again worked briefly as a team during initial SBO development. They participated in the preparation only to the extent necessary to give them an appreciation of that part of the process. Consequently, they were able to judge the correctness of the contractor's interpretation of the technical subject matter proposed for training. They also provided insightful recommendations about enabling skills and knowledges that needed to be trained to achieve the behavioral objectives.

The last major interface of the Navy/Grumman ISD team occurred in the preparation of the Lesson Specifications. Contractor training experts presented a "straw-man" syllabus proposing how the various SBOs and lessons might be combined into a training program. In addition to suggesting recommendations for the sequencing of lessons, the SMEs provided consultation on existing curricula, and such information as phases of training, ancillary training which replacement pilots and B/Ns receive during their time in the Readiness Squadron, and coordinated training phases such as the Visual Weapons (VISWEPS) phase. With this information the development of Lesson Specifications could then be completed.

This use of the SMEs proved to work quite satisfactorily. Appropriate and sufficient support was provided to contractor personnel, while interruptions to the daily routines of the squadrons appeared to be small but acceptable. The total time required of all SMEs during Phase I is indicated in Section IV.

MEDIA RECOMMENDATIONS AND LESSON SPECIFICATIONS. The recommendations resulting from the media analysis reflect contractor judgement as to what might reasonably be expected with regard to media availability and use. It was thought to be totally impractical to merely recommend the best type or mix of media to satisfy particular learning objectives without regard to the extent of new media development that might be required. On the other hand, to limit recommendations to available media could seriously curtail the quality of training that might be achieved.

The solution to this problem was as follows. The recommendations made in the media analysis[2], represent what is considered to be the preferred type or mix of media in satisfying the various learning objectives. In instances where these represent media which are not currently available, for example WST with a land-mass visual capability, or which, although available, lack a particular capability, for example, SCEPTR, a procedures trainer for B/N Weapons System Training, alternatives are listed. These alternatives are acceptable although they may provide a less desirable training mode or a more costly mode. For example, a WST with visual capability could provide FLR visual and display imagery and carrier landing training capability, which otherwise would have to be performed on the operational aircraft. Functional descriptions of these trainers, preliminary in nature, are included in the media report.

In other instances, media recommendations assume that existing media will be partially or substantially updated. Here it is anticipated that such updating will be accomplished as part of Phase II. This category includes sound-slide program updating and updating of the pilot SCEPTR to an A-6E TRAM configuration. It is further expected that some new media will be developed during Phase II. Included in this category are sound-slide programs, charts, video tapes and similar "software".

This approach, matching SBOs and media was carried through to Lesson Specifications.[2] Here, however, it was felt paramount to present media recommendations which would allow a training program to be developed and conducted. Insisting on media which may or may not be developed in the near future does not bring us to that goal. Therefore all media recommendations shown in the Lesson Specifications are limited to those which can be prepared for an imminent training program. The potential benefits to the training program identified through the ISD process will be largely wasted however unless the media recommendations, to wit, visual capability added to WST, and development of pilot and B/N procedures trainers, are implemented.

THE IDENTIFICATION AND USE OF PERFORMANCE STANDARDS. A key feature of the ISD process is the emphasis placed on clear, well-defined behavioral objectives. The trainee in an ISD based training program should understand as precisely as possible not only what is expected of him and what he must learn and do to get there, but also what criterion level of performance he must exhibit to demonstrate he has achieved that expectation. Where tasks

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1 J. Feddern, G. Graham, S. Campbell, and M. Morganlander, Training Support Requirements (Media Analysis), A-6E (TRAM) Aircraft, Grumman Aerospace Corp., Bethpage, N.Y., Report ISD (SAT) 0004, Feb. 1976.

2 G. Graham, and J. Feddern, Lesson Specification Documents, A-6E (TRAM) Aircraft, Grumman Aerospace Corp., Bethpage, N.Y., Report ISD (SAT) 0006, April 1976.

or activities are relatively simple, or where they lend themselves to readily quantifiable or measurable standards, little problem is experienced. Typical classroom learning activities permit reasonably well-defined performance standards. For example, the number of items correct minus number of items incorrect in a written test yields a score which can be easily compared with a pre-set standard.

Few of the pilot and B/N activities lend themselves to such a simplistic scoring scheme. In general the activities of the aircrewman involve a sequence of coordinated, complex and integrated activities directed towards a two-faceted goal: performing the assigned mission successfully and safely. Within the boundaries of this practical goal much individual variation is acceptable. The instructor very often is called upon to "rate" the pilot and B/N on rather large-scale categories such as instrument procedures, formation procedures, fuel planning and monitoring, landings, headwork and agressiveness. These ratings are made on a series of flights wihin a given phase of training. The ratings are qualitative in nature with the replacement pilot or B/N performance being located on a scale, ranging from above average through marginal or unsatisfactory. Documented information on specifically what should be demonstrated by the replacement pilot to achieve a "SAT" rating is not generally available.

And yet, surprisingly, or perhaps not so surprisingly, there is a realtively good correlation among instructors in rating trainee performance. Experience has shown that given a set of veteran instructors, all evaluating the same performance, markedly good agreement would likely be found. Further, without having verbalized the criterion performance desired, instructors do tend to transmit to the "rookie" their expectations, e.g., a turn point not precisely navigated, a coordinated turn too loose, an approach too high.

The performance standard demanded is zero error, whether flying the ball, navigating to a check point or placing cursors squarely on target. Some composite deviation from zero error, if small enough in the judgment of the skilled instructor represents satisfactory performance. The instructor continually attempts to narrow down the corridor of deviant performance, to reduce the range of error, until the performance is judged at least average-a zeroing in on acceptable performance.

The lack of objective performance standards became a problem during the process of developing the SBOs. The ISD process called for the identification of quantitative performance standards, both for operational performance as well as for criterion test behavior. Although the SMEs were extremely cooperative and helpful, not very many documented standards were available. There was generally concurrence between Navy and contractor team members that the more precisely and clearly the standards could be defined for the trainee, the more appropriate would be his attempts at achieving that behavior. There was somewhat less concurrence on the likelihood of developing such standards or their suitability for use with the kind of activities involved. Further, a natural concern existed that should operational standards be identified, they would promptly be considered as "cast in concrete" before their assessment, and that they would either be prematurely introduced into, or rejected by, training squadrons; or that they might be misused or adapted incorrectly in the training program.

After careful examination of the alternatives the decision was reached to see what success might be achieved in developing these quantitative standards. Attempts at describing performance levels soon indicated that the instructors did indeed have an internalized criterion set that they used in rating their students. Open discussion of these eventually yielded a set of standards that were then associated with the SBOs and used in developing the Lesson Specifications. There was a general tendency to want to "open up" the standards somewhat, but those identified have general squadron SME concurrence as a "preliminary set". They are found mainly in the area of B/N activities, which in general tended to allow examination of more discrete segments of activities than did the pilot tasks.

SECTION III

IMPLEMENTATION

TASK ANALYSIS

INTRODUCTION. The job/task analysis phase of the ISD process was performed by a team consisting of Navy Subject Matter Experts (SMEs), and contractor training psychologists, educational specialists and flight test personnel. The goal of this phase was to identify the tasks that an A-6E TRAM pilot and B/N would be called upon to perform in the operational environment. These tasks were to be described in sufficient depth to permit an identification of the underlying skills and knowledges which the crewmen must possess in order to successfully perform the tasks.

The job/task analysis was preceded by a compilation and review of engineering, flight test and operational documentation of the A-6E. It consisted of in-house A-6 data obtained from various contractor departments and Navy documentation obtained from VA-42. The compilation formed a library encompassing the full range of aircraft and on-board equipment information, operation and functional descriptions. This library, enhanced by continuing dialog with Navy SMEs represented the technical source reference materials for this and subsequent phases of the study. This data was later supplemented by documents from VA-128.

To further ensure consistency with the design goal of creating an aircrew training program specific to the performance requirements of an operational environment, a mission scenario was developed to aid the generation of job/task descriptions and subsequent analysis. The scenario consisted of a typical sequence of major events that would take place during a nominal A-6E mission. Generally, it began with mission briefing and planning, followed by aircraft preparation for flight, take-off and climb operations, a tactical phase, aircraft return, descent, landing, post-flight aircraft check and shutdown and debriefings. Where alternative events could occur, e.g., take-off from a field vice a carrier, a parallel event flow was prepared. The tactical phase, which involved many alternatives depending on specific mission and weapon delivery options, was expanded to provide a logic flow approach, specifying the conditions leading to the choice and exercise of various options. Included in the tactical portion of the scenario was air combat maneuvering and flight to and from target area.

This scenario was then used in generating the nominal pilot and B/N activities performed in accomplishing the events. Finally, since non-nominal, malfunction and emergency situations might occur at various times in a mission, these were identified independent of the mission scenario and the pilot and B/N activities dealing with these situations were identified and described. It was recognized that certain aspects of malfunctions were mission dependent, i.e., had different corrective action or aircrew responses according to where in the mission they occurred, for example, engine failure prior to take-off, vs engine failure in flight. In such instances pilot actions under both conditions were identified.

Applying the ISD principle of employing a methodological and systematic process in the identification of job/task elements, the task analysis effort began by establishing a hierarchy for describing the pilot and B/N behaviors during a typical mission. The hierarchy, as structured, generally included three levels of description. It was generated by defining each phase of flight in terms of major mission events, the tasks which comprise the

events, and finally, the steps which describe the incremental actions an aircrewman must take to complete a task. Occasionally step-level activities required an additional subdivision. This necessity arose where the complexity of the crewman's activity was such that further description was needed.

The identification and description of the crew activities was accomplished in a series of working sessions with the SMEs. Following each session the training and educational specialists regrouped to summarize, organize and arrange the information discussed into a preliminary task listing. This listing was reviewed, modified and updated via SME reviews until a technically satisfactory listing was completed. This listing was then reviewed by SMEs from VA-128.

Following the development of task listings, an analysis of the training requirements related to the tasks was conducted via a series of interviews with the SMEs from both squadrons. A form entitled the Task Analysis Record Sheet (TAR) had previously been prepared to aid in collecting this data. As had been anticipated, the detailed analysis resulted in the generation of thousands of task statements and a substantial amount of related data. Recognizing that manual manipulation of such huge amounts of data would be exceedingly laborious and time consuming, an electronic data processing system was established, the commercially available MARK IV General Data Management System. Development of this system allowed the sorting and assembling of both task descriptions and supporting data.

THE PROCESS. Essential to the analysis process was the establishment of a selective yet comprehensive library of source data. Acquisition of documentation, an activity which continued for the duration of the study, began within the contractor organization. Engineering, Life Sciences, Publications and Flight Test Department files were reviewed for information pertaining to A-6 and A-6E/TRAM A/C. The result was a complete compilation of A-6 NATOPS manuals, Grumman Data Packages for the TRAM configuration, specifications for the A-6E Weapons System Trainer, and other related engineering analysis and design data. A survey of these documents provided contractor personnel with an understanding of the A-6 Pilot and B/N operational activities sufficient to develop our initial thoughts as to how the Task Analysis was to be accomplished.

It was obvious that the Navy/contractor ISD team which was to be formed to perform the analysis was to be composed of personnel with diverse professional backgrounds. The contractor personnel assigned to the ISD team had the greater proportion of their work experience in the field of education and training, some experience in aircraft design but a relatively limited understanding of (and no experience in) the operation of the A-6 aircraft. On the other hand the SMEs had extensive flight experience with limited knowledge of the ISD process. It was recognized that any planned approach for building an integrated work team required a blending of these diverse talents through the establishment of a common frame of reference.

For the VA-42/contractor team this frame of reference, was a jointly developed typical mission scenario. Ancillary to the development of the scenario, but just as important, was the education of SMEs in the ISD process. With this understanding in mind the work activity was planned according to the following procedure:

a. Set forth an approach for development of a typical mission scenario.

b. Conduct informal briefings of SMEs on the ISD philosophy and process.

c. Collaborate with SMEs in the development of the mission scenario.

d. Develop a job/task hierarchy as a result of working sessions with naval aircrew-men with A-6 operational experience.

e. Conduct a job/task analysis resulting in a task listing.

f. Develop a computer-based sort system to aid in the manipulation of job/task data.

g. Initiate ongoing technical monitoring of contractor activities by SMEs.

Initially, the contractor ISD specialists developed a typical mission flow chart using as principal technical references:

- A-6 NAVAIR 01-85-ADA-1B NATOPS Pocket Check List
- A-6 NAVAIR 01-85-ADA-1 NATOPS Flight Manual
- Grumman Data Packages for Integrated Weapons System Theory - Preproduction TRAM A/C
- Grumman Flight Test Personnel

The flow chart provided a pictorial representation of a typical mission consisting of nominal mission activities (those activities common to all missions) and tactical activities (those activities which are unique within a mission as required by weapons mix and/or delivery mode). The first evolution of the flow chart identified major pilot and B/N activities such as Preflight Checks, Exterior Inspection, Prestart Procedures, etc. This level of aircrew activity identification was designated, for the task hierarchy, as EVENT level activities. The flow was completed from preflight through aircraft land or carrier recovery and post flight operation.[1] Nominal flight activities were comparatively well-defined for the EVENT level in that there was sufficient information available from Grumman Flight Test personnel and the reference documents. However, the tactical activities were superficially identified; it was apparent that a substantial SME input would be required for this portion of the job/task definition.

A second iteration of the flow was then accomplished to further expand each of the event level activities in terms of crew TASKS which comprise the EVENT and the incremental STEPS taken to accomplish each TASK.

These early ISD activities served a threefold purpose: first, to educate contractor educational specialists with regard to pilot and B/N operational duties; secondly, to establish a technical frame of reference which was mutually understood by both contractor personnel and the Navy subject matter experts; and thirdly, to establish a method by which the identification of job/task data would be pursued.

Having developed the mission scenario to a point where there was confidence in both the validity of the approach and the information contained therein, VA-42 subject matter experts were consulted for a technical review of the work accomplished and to discuss their role and technical input for further definition of operational activities.

1 The scenario was developed as a working tool, and as such is unpublished.

The objectives of this first technical conference with VA-42 subject matter experts include the following:

- Technical verification and update of work accomplished
- Identification and definition of additional nominal mission events
- Identification and definition of activities within each event
- Definition of the independent and interdependent aspects of the job/tasks identified
- Acquisition of additional documentation specifically related to aircraft operation

The conference was conducted at VA-42 NAS Oceana, Virginia. Two contractor training specialists and two Navy subject matter experts (VA-42 pilot and B/N) were present. The mission scenario was reviewed with the SMEs for format and content with all four team members participating. This total team effort continued through the identification of all major nominal events. The team then split into two subgroups, one to work principally on pilot activities, the other B/N activities. Each subgroup consisted of one subject matter expert and one training specialist, with the SMEs talking the latter personnel through each event using their personal knowledge and Navy documentation as references, and assuring themselves that the training specialists had a sufficient understanding of the operations involved. Periodically the subgroups reconvened as a team for status assessments which also served as reviews and technical cross checks of work accomplished, and for discussions regarding interdependent crew activities. The educational specialists carefully documented these working group interviews for later use during the writing of the task and step levels of the job/task hierarchy.

The results of the conference were: (1) the mission scenario was completed for all major nominal events; (2) the SMEs provided an elaboration of the activities occurring within each event including identification of independent and interdependent tasks; (3) initial discussions regarding the further development of tactical events were held; and (4) the SMEs provided additional reference materials, i.e., VA-42 A-6 Training Syllabus, briefing guides, lecture outlines, student progress folders, and samples of various forms and charts used within the squadron, e.g., aircraft inspection form (yellow sheets) and navigation charts.

Using the newly acquired information, contractor ISD specialists completed the job/task hierarchy for the nominal mission activities. Figure 2, a representative sample of Event 25, Pre-Approach, is included as an example of how the information obtained from the SMEs was organized and recorded by the training specialists.

Subsequent conferences followed the same work schedule, i.e., the review and update of contractor accomplishments followed by subgroup and total team activities for the generation of new material. This proved to be a highly efficient and productive method for working with the SMEs.

The following two conferences with the VA-42 SMEs and the intervening contractor work-alone periods resulted in completion of the typical mission scenario; the derived preliminary task hierarchy and nominal task listing; and a preliminary task listing of emergency procedures and system malfunctions. About the time of the second conference a transition of SMEs of VA-42 was begun; it was completed without any delay to the work effort by the time of the third meeting.

E25 PRE-APPROACH

T1 CONTACT APPROACH CONTROL AGENCY (B/N)

S1 SET UHF FREQUENCY FOR APPROACH CONTROL

S2 IDENTIFY A/C, LOCATION AND ALTITUDE

S3 REQUEST PERMISSION FOR AN APPROACH

S4 INDICATE LANDING INTENTIONS

S5 RECEIVE APPROACH CLEARANCE AND EXPECTED APPROACH CLEARANCE TIME (EAC)

S6 RECEIVE HOLDING INSTRUCTIONS (IF REQUIRED)

T2 BEGIN PENETRATION (DESCENT) CHECKLIST (COORD)

NOTE: BEFORE DESCENT AND AFTER PROLONGED COLD
**SOAKING AT HIGH ALTITUDE COCKPIT TEMPERATURE **
**SHOULD BE INCREASED AND DEFOGGING ACTIVATED **

S1 ADJUST *AUTO TEMP CONT* POT..........................INCREASE (*HOT*) (P)

S2 ADJUST *DEFOG: AIRFLOW* POT......................... *ON* AND INCREASE AS REQUIRED (P)

S3 REFILE ALTERNATE (DIVERT AIRFIELD) CLEARANCE REQUEST.......................... AS REQUIRED (P & B/N)

S4 CHECK FUEL (B/N)

(a) VERIFY MAXIMUM GROSS WEIGHT

(b) VERIFY *FUEL QUANTITY* IND....APPROPRIATE FOR LANDING

(c) DUMP FUEL (IF REQUIRED) (SEE E25 T4) (COORD)

S5 CHECK WEATHER (VIA RADIO) (B/N)

S6 CHECK AND SET PRESSURE ALTIMETER FOR FIELD PRESSURE (RECEIVE VIA RADIO FROM APPROACH CONTROL) AND READ BACK (P)

CAUTION: UNLESS CABIN IS DEPRESSURIZED, DO
**NOT ACTUATE LANDING GEAR ABOVE 8000 FEET **

Figure 2. Sample of Task Listing for Pre-Approach

At this point, the existing ISD team took time out to welcome aboard a second group of SMEs, a Pilot and B/N from VA-128 Readiness Squadron stationed at NAS Widbey Island, Washington. Presentations similar to those provided earlier to VA-42 SMEs were given the VA-128 members - on the generic ISD process and the application of its methodology to the implementation of the contracted A-6E TRAM Phase I study. The remaining conference time was devoted to a detailed review of the task listings. Comments and specific suggestions made by VA-128 SMEs were discussed and appropriate modification were made. This third party technical review was in effect, a validation of the work accomplished. The addition of a second group of SMEs to the ISD team was without notable problem and proved to be, over the course of the study, most beneficial.

The task listings resulting from the job analysis comprised over 400 nominal pilot tasks each with an average of approximately 10 steps; 70 airframe emergency sequences involving an average of 7-10 steps in each, 35 system malfunctions, and more than 200 nominal B/N tasks, also averaging about 10 steps each. The approved task listings are contained in the following publications:

- ISD (SAT) 0003-1 Task Listing, A-6E (TRAM) Aircraft Pilot Procedures, Vol. I, Sept. 1975
- ISD (SAT) 0003-2 Task Listing, A-6E (TRAM) Aircraft B/N Procedures, Vol. II, (Confidential), Sept. 1975
- ISD (SAT) 0003-3A Task Listing, A-6E (TRAM) Aircraft Airframe Emergencies and System Malfunctions, Volume III, Oct. 1975

Classified pilot aircombat maneuvering tasks were included in Volume II, (already classified confidential) to avoid producing a second classified document.

The listings represent tasks for which training needed to be conducted at the Readiness Squadron level, either as introductory training or as follow on to training received at the Air Training Command for the pilots or in previous assignment in the case of the B/Ns.

No attempt was made to assess the appropriateness of the Readiness Squadron location for this training, or to judge the extent of entry level skills and knowledges of the RP and RBNs. The statement of the SMEs as to where the training for the listed tasks occurred was merely accepted without questioning. To extend the analysis either to earlier assignment or to examine operational squadron training requirements and jurisdiction, although highly desirable, was beyond the bounds of the current effort.

TASK SELECTION

Having stabilized the task listing to the mutual satisfaction of all team members and having gained the approval of the NAVTRAEQUIPCEN project director, the next step in the process was to conduct a training requirements analysis, the purpose of which was to examine the task listing and to identify and extract those factors or characterisitics of the task which influenced the training which would be conducted. These factors include:

a. The aircrewman responsible for performing the task, and whether the task was coordinated or shared with the other crewman

b. Where training was currently being conducted

c. The skills and knowledges implicit in the tasks

d. The conditions under which the tasks were to be performed, e.g., IFR or VFR, at night or during daylight

e. The kind of cues available to the crew members (e.g., a feel or sound; a visual cue internal to the cockpit as a gage reading or status light; a sequence with the preceding step becoming the prerequisite for the next)

f. The aircraft system or systems involved

g. The degree of difficulty in performing the task

h. An indication as to what factors contributed to the task difficulty, e.g., limited time, lack of available cues, anxiety factor, unfamiliar situation, etc.

i. The criticality of the task in terms of its impact if performed erroneously or not at all, e.g., degrade mission or result in possible crash/death

j. The important performance measurement feature involved, e.g., accuracy, precision

k. Other special factors which impact training, e.g., requires frequent practice, etc.

To aid in the gathering of this training requirements data, a form was constructed, entitled Task Analysis Record (TAR) (see Fig. 3). With these forms, the training and educational specialists interviewed the SMEs to obtain their judgments on the behavioral, conditional, performance and operational aspects of the task examined. One group of SMEs aided in defining the form content, both groups performed independent assessments of the tasks under the guidance and direction of the training and educational specialists. The information obtained therefrom was used in instructional sequencing and blocking downstream in the ISD process, and as an aid in selecting appropriate instructional strategies.

A word about one of the TAR items, skills/knowledges, seems appropriate here. It was recognized that the analysis of the operational tasks identified in the Task Listing was concerned not only with the terminal behavior described by the task statement, but also with the underlying skills and knowledges which the RP or RBN needed to have in order to successfully perform the task. A workable hierarchy of skills and knowledges was required which would allow development of sound, workable Specific Behavioral Objectives (SBOs). Lumsdaine,[1] in 1960 indicated that the first questions to be asked in designing a training program are:

1 Lumsdaine, A.A., Design of training aids and devices, in J.D. Folley, Jr (ed.), Human factors methods for a System Design, American Institution for Research, Pittsburgh, Pa., for Office of Naval Research, Report AIR-C90-60-FR-225, 1960.

GRUMMAN AEROSPACE CORPORATION
BETHPAGE NEW YORK 11714

TASK ANALYSIS RECORD

PROGRAM ________________

TASK LISTING			TASK NUMBER	SPECIFIC BEHAVIORAL OBJECTIVE NUMBER	SHEET OF
VOL.	PAGE	DATE			DATE

A. CREW
1. Pilot
2. B/N
3. Coordinated
4. Shared

B. LEVEL
1. Tng. Cmd.
2. RAG
3. Opr. Sqn.
4. Other

C. SKILLS/KNOWLEDGE
1. Simple Response
2. Procedure
3. Discrimination
4. Complex Response
5. Knowl./Mental Skills
6.

D. CONDITIONS
1. IFR
2. VFR
3. Land
4. Carrier
5. Weather
6. Degraded System
7. Emergency
8. All
9. Other

E. CUE (INT/OPER)
1. Vis. Int.
2. Vis. Ext.
3. Weather
4. Sound
5. Feel/Smell
6. Checklist
7. Mission/Tactical
8. Directive (Rules/SOP's)
9. Sequential

F. SYSTEM
1. Engine
2. Fuel
3. Hydraulic
4. Flt. Control/AFCS
5. Electrical
6. Environmental
7. Personal Equipment
8. Radio Comm/Nav
9. Instruments
10. Computer
11. CAINS
12. Radar
13. ADC
14. Radar Alt/Doppler
15. DRS
16. ACU
17. ECM
18. Other

G. DIFFICULTY DEGREE
1. Not
2. Mildly
3. Moderately
4. Very

H. DIFFICULTY FACTOR
1. Cues Available
2. Many Controls
3. Precise Manip.
4. Limited Time
5. Specific Sequence
6. Decision/Equip.
7. Decision/Sit
8. Decision/Miss
9. Req. Anticip.
10. Anxiety
11. Unfamiliar
12. Exertion
13. Discomfort

I. CRITICALITY
1. None
2. Degrade Mission
3. Minor Damage
4. Major Damage/Injury
5. Crash/Death

J. PERFORMANCE MEAS.
1. Accuracy
2. Precision
3. Time
4. Consistency
5. Other

K. SPEC FACTOR
1. Req. Freq. Pract.
2. Req. Rote Mem.
3. Req. Certification
4. Unforgettable
5. Natural
6. Normal Recurring
7. Other

REMARKS: (Explain all items checked other)

Figure 3. Task Analysis Record Form

- What are the final human performances that should be obtained?

- What are the specific things that need to be learned to make this criterion performance possible?

- Who is to learn them? What are his abilities and motivations, what part of the total required skills and knowledges does he already have?

In distinguishing among the different classes of things trainees may need to learn, Lumsdaine arrived at a five-part classification of training objectives which pose different requirements for training devices to satisfy those objectives. The categorization of task activities, labeled under the heading Task Components on the Task Analysis Form provided in the Grumman proposal [1] (see Fig. 4) basically followed this classification. Additionally, because the task activities of the B/N involved a considerable amount of scope reading and interpretation another category was added, perceptual discrimination, as was recommended by Parker and Downs[2]. It was found convenient to expand some of the knowledge classifications later on in preparing the behavioral objectives and lesson specifications. Here, a principle influence was Bloom's Taxonomy for cognitive domain [3].

The six or seven classification taxonomy used during the gathering of the training requirements data proved to be appropriate. Although by comparison to other classification schemes examined, it might be considered by some taxonomists to be "light" in the cognitive areas, it had the advantage of being tailored to reflect the emphasis on performance inherent in the vast majority of pilot and B/N tasks. It was found fairly straight-forward to expand the knowledge classification later on in SBO development as the need became evident, as will be described later in this section.

Data Management System. A computer based data management system was designed as an aid for the manipulation of data during task and training analysis. The system selected was the commercially available MARK IV General Data Management system. The system is capable of sorting and assembling a wide variety of crew activity information. The system operates on a task data base which includes:

a. Event, task, step level activity descriptors written in natural language.

b. Identification of activity by aircraft work station, i.e., pilot, B/N, shared and coordinated.

c. Descriptive data to be used in the training requirements analysis of task data, e.g., task related criticality factors.

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1 op. cit. p. 24.

2 J.F. Parker, J.E. Downs, Selection of training media. Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Report ASD TR-61-473. Sept. 1961.

3 B.S. Bloom, (ed.), et al., "Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: Cognitive Domain", N.Y.: Longmans, Green & Co., 1956.

CODE	TASKS	TASK LEVEL			WORK STA OPERATOR POSITIONS (AS PER A/C)	S	SUBSYSTEM EQUIPMENT			CRITICALITY					TASK COMPONENTS						TRNG LOCAT			TYPES OF MISSIONS (AS PER A/C)	TYPE A/C		
		R	D	A			EE1 TACAN (APN12)	EE2 IFF (APX-70)	EEN	TIME	ACC	REP	DIFF	CMPLX	KNOWL	EVAL	MANIP/PROCED	D-M/JUDGE	PERC/MOTOR	MONIT/PERC DISC	OPN SQD	RAG	ATC		A-6E	E-2C	EA-6B

Figure 4. Task Analysis Form – Proposal

The input format of the data system comprises a six-card input. Cards No. 2 through 6 are assigned to the task descriptions in natural language. Card No. 1 is reserved for training analysis data. The computer program is sufficiently flexible to allow for a variety of output reports, a capability of particular value during the training analysis phase. It would be highly useful to continue the program development so as to include both SBOs and lesson data and to relate these to the task hierarchy. Such a scheme would permit tracing the impact of any aircraft system or hardware change down to a particular lesson within the syllabus. However no funds were allocated for this development.

SBO and lesson specification data consequently were manipulated manually. This lack of electronic data processing did not seriously impact the job because only two job descriptions, pilot and B/N were being analyzed. Such support would be almost imperative for performing the ISD process for operations involving multiple assignments, e.g., shipboard operations or multiple activities, e.g., maintenance operations. Further, completion of the program might provide a convenient tool for Navy updating of the training program once it is in operation.

SPECIFIC BEHAVIORAL OBJECTIVES (SBOs)

INTRODUCTION. In designing an Instructional System, the next step which was taken was the development of task related specific behavioral objectives. In the past, training curricula were often developed around lofty and vague goals, and learning outcomes often lost the necessary relationship to the operational tasks. The utilization of SBOs in establishing training curricula virtually eliminates this undesirable result. The development of SBOs began with the establishment of major categories for a Taxonomy of Training Objectives. This taxonomy was to be an important tool in the next two activities of the process, the first of which was completing the Task Analysis Record sheets. The contractor, with the aid of the VA-42 and VA-128 Subject Matter Experts (SMEs), reviewed the pilot and B/N Task Listings and dcoumented, on the Task Analysis Record Sheets, selected information, i.e., crewmember, conditions, system involved which would be valuable in developing the SBOs. To develop the SBOs, all the high level job related behaviors had to be identified first, i.e., behaviors that repeat or closely resemble the behavior required in performing the task. The task listings were exhaustively analyzed, task by task and step by step. The behaviors generated constituted the heart of the Terminal Objectives (TOs).

The high level behaviors were analyzed next, to identify the enabling behaviors. These behaviors are the prerequisites to the performance of the job related behaviors and became the basis for the Enabling Objectives (EOs). This behavioral information, together with the information gathered on the Task Analysis Record Sheets, formed the groundwork for the construction of the SBOs and the formation of an objectives hierarchy, i.e., a sequence of EOs supporting a TO. Of the 373 SBOs identified, 105 were Pilot related, 109 B/N related and 159 involved both crewmen. The SBOs were documented in three separate volumes [1-3] and submitted to Naval Training Equipment Center for review and approval.

1 S. Campbell, G. Graham and S. Hersh, Specific Behavioral Objectives and Criterion Test Statements, Pilot Procedures A-6E (TRAM) Aircraft (Vol. I), Grumman Aerospace Corp., Bethpage, N.Y., Report ISD (SAT) 0003-4, December 1975.

2 J. Hanish and J. Feddern, Specific Behavioral Objectives and Criterion Test Statements, Bombardier/Navigator Procedures, A-6E (TRAM) Aircraft, Volume II, Grumman Aerospace Corp., Bethpage, N.Y., Report ISD (SAT) 0003-5, Dec. 1975.

3 G. Graham, J. Hanish and S. Hersh, Specific Behavioral Objectives and Criterion Test Statement, Airframe Emergencies and System Malfunctions, A-6E (TRAM) Aircraft (Volume III) Grumman Aerospace Corp., Bethpage, N.Y., Report ISD (SAT) 0003-6, Dec. 1975.

PROCESS. The initial activity in developing SBOs was the establishment of a suitable taxonomy of training objectives. To this end, the ISD Group reviewed taxonomies developed by Bloom[1], Lumsdaine[2], Krathwohl[3] and the Department of the Air Force[4]. The taxonomies developed by Bloom and Krathwhol were heavily slanted toward the cognitive and the affective domains while the Air Force taxonomy leaned toward the psychomotor domain. Some consideration was given to integrating the categories of all of the taxonomies; however, the resultant large number of categories that would have required examination for each behavior would have led to delay and confusion. It was decided to limit the number of categories in the taxonomy by judiciously selecting what was considered knowledge and skill categories pertinent to the immediate task. In addition, the elimination of the affective domain categories was made possible by recognizing that the students are replacement pilots and B/Ns who are carefully selected, highly motivated and painstakingly screened in prior training programs. This resulted in the establishment of a taxonomy of training objectives specific to flight crew operations (Table 3).

The second step of the process involved performing an analysis to identify task related training factors i.e., the subject of the tasks, the skills and knowledges required, the conditions under which the task will be performed, potential cues, the systems exercised, the degree of difficulty associated with performing the task, the criticality of the task, the performance measurements and the special considerations involved. A list of potential training factors was identified and documented in a standard form, the Task Analysis Record Sheet (Figure 3). The correlation of these training factors to Pilot and B/N tasks was a team effort, involving Navy SMEs from VA-42 and VA-128 as well as contractor Educational Specialists. The SMEs provided the invaluable aspects of experience and operational expertise needed to relate each training factor to a task operation. This relationship was permanently recorded on the Task Analysis Record Sheets and in the Data Management computer file for future use in:

- Developing SBOs
- Blocking and sequencing SBOs

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1 op. cit., p. 43.

2 op. cit., p. 41.

3 Krathwohl, D. R., Taxonomy of Educational Objectives - Its Use in Curriculum Building and Defining Educational Objectives, University of Pittsburgh, Pa., 1964.

4 AFP 50-58, op. cit., p. 12.

TABLE 3. TAXONOMY OF TRAINING OBJECTIVES

1.0 Knowledge

1.1 Technological - Learning "how to" perform a single switch and control configuring procedure. Learning "how to" read meters, digital displays, scopes, lighting displays, etc. In general, learning "how to".

1.2 Formal - Learning the meaning of special symbols, acronyms, words, nomenclature, etc.

1.3 Descriptive - To describe "what is" and "what was": facts, data, special information about systems, subsystems, equipment, weapons, tactics, missions, etc.

1.4 Concepts and Principles - Fundamental truths, ideas, opinions and thoughts formed from generalizations of particulars.

2.0 Comprehension

Understanding the meaning of meter readings, scope, digital and lighting displays. Understanding the switch and control configuring procedure, i.e., the reason for a specific sequence, the reason for a switch or control position, the reason for a verification, etc.

Grasping the meaning of concepts and principles, i.e., understanding the basic principles of infrared and radar detection.

Understanding the meaning of facts, data, specific information, etc.

3.0 Discrimination

Distinguishing among different external stimuli and making appropriate responses to them, e.g., scanning gages for out-of-tolerance trends. Also includes the recognition of the essential similarity among a class of objects or events, e.g., classifying aircraft types or radar return images.

4.0 Application

4.1 Simple Procedure - A demonstration of a simple learned procedure in the cockpit or simulator requiring not more than simply repeating required switch and control configuring and simple visual verification, i.e., advisory light status.

4.2 Complex Procedure - A demostration of a learned procedure in a cockpit or simulator that requires differentiating or distinguishing between readings on meters, digital displays, and images on video and radar displays and interpreting and applying the meaning of the readings and images.

4.3 General - Using learned materials in new and concrete situations, e.g., using rules, methods, concepts, principles, procedures, etc.

TABLE 3. TAXONOMY OF TRAINING OBJECTIVES (CONT'D)

5.0 Analysis

A demonstration of a learned process of breaking down material i.e., data, other information into its components so that it may be evaluated with respect to crew safety, mission success, A/C maintenance, etc.

6.0 Synthesis

A demonstration of a learned process, e.g., putting tactical elements together weapons, targets, available systems, A/C capability, etc.) to formulate a mission.

7.0 Evaluation

A demonstration of a learned process of assessing or judging a system or situation, based on criteria i.e., data, rules, available equipment, conditions, etc. and then reaching a conclusion based on this assessment.

8.0 Complex Performance

A demonstration that requires psychomotor skills and/or critical thinking skills usually requiring practice.

In step three of the process, the characteristics of the Specific Behavioral Objective were identified. Contractor Educational Specialists reviewed the works of such authorities in the field as Robert R. Mager[1], Robert M. Cagne[2], David R. Krathwohl[3], the Department of the Air Force[4] and the U.S. Training and Doctrine Command[5], and concluded that they all essentially agreed on the content of an SBO. A well-prepared SBO contains the following:

a. A description of the learner

b. A specific description of the behavior, expressed as an action, that the learner is to exhibit after training

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1 R. R. Mager, Preparing Objectives for Programmed Instructions, San Francisco, Ca., Fearon Publishers, 1962.

2 R. M. Gagne, The Analysis of Instructional Objectives, Paper for National Educational Association (NEA), 1963.

3 Krathwohl, op. cit., p. 46.

4 Department of Air Force ATP 50-58, op. cit.,p.12.

5 U.S. Training and Doctrine Command, Interservice Procedures for Instructional Systems Development, Vols. I-V, Center for Educational Technology, Florida State U., for U.S. Training and Doctrine Command, Report TRADOC Pamphlet 350-30, Aug. 1975.

c. The conditions under which the action will take place

d. The minimum acceptable performance standards under which the desired behavior is to be exhibited.

Two classifications of SBOs were identified: terminal and enabling. The Terminal Objective (TO) is the highest level of behavioral change that can be associated with a task and is usually directly job related, e.g., "The RBN will copy and analyze all frozen data from the DDU and DVRI without omission or error." The Enabling Objective (EO) is the lower level behavioral change or, prerequisite that must be achieved prior to being able to perform the TO, e.g., the student must understand the relationship between the DDU and the DVRI frozen data and the ensuing impact error analysis prior to analyzing the data. Experience indicates that there is usually at least one EO for each TO.

The next step was to develop a standard report format for recording identified SBOs. The result was the Instructional Systems Design Record (Fig. 5) which contains the following information:

a. Task Listing - Reference to specific volume and page of the A-6E TRAM Task Listing.

b. Task Number - Specific event (E), Task (T) or Step (S), from that Task Listing, for which the SBO has been written.

c. Task Responsibility - Indicates prime responsibility for the task, pilot, B/N, coordinated or shared (both).

d. Task Statement - A statement of the operational activity expected of the pilot and/or B/N.

e. Conditions/Constraints - Statement of the operational conditions or operational constraints against which the tasks might need to be performed. Where this segment of the form is left blank, e.g., for many conditional performance activities (malfunctions), no qualifying conditions or constraints, which might differentially affect the task performance, have been identified.

f. Performance Standard - The standard against which the operational performance is judged. Meeting this standard in the fleet affirms that the task activity has been satisfactorily performed. The standards indicated reflect the consensus arrived at during working sessions with VA-42 and VA-128 SME personnel.

g. SBO Statement - The learning outcome expected to be achieved and exhibited at the conclusion of training in the Readiness Squadron. SBO statements may be classified as Terminal, the final behavior to be exhibited, or Enabling, a learning outcome prerequisite to a terminal behavior.

h. SBO Number - A unique identifying number for each SBO.

i. Skill/Knowledge Class - A hierarchial classification of skills and knowledges implied in the performance of the specified behaviors. May range from simple

GRUMMAN

INSTRUCTIONAL SYSTEMS DESIGN RECORD

PROGRAM ____________________

TASK LISTING			TASK NUMBER	TASK RESPONSIBILITY	DATE
VOL	PAGE	DATE			
					SHEET OF

TASK STATEMENT	CONDITIONS/CONSTRAINTS	PERFORMANCE STANDARD

SPECIFIC BEHAVIORAL OBJECTIVE	TERMINAL		ENABLING		SPECIFIC BEHAVIORAL OBJECTIVE NO.
					SKILL/KNOWLEDGE CLASS

CRITERION TEST	CRITERION TEST NO.
	TEST TYPE
	TEST FORMAT

PAGE

TRAINING SYSTEMS DEPARTMENT

Figure 5. Instructional Systems Design Record

knowledge through the higher order mental functions of analysis or evaluation, or from simple procedural responses to complex psychomotor performance. This block is intended for use during development of instructional strategies, sequencing of instructional blocks, and formation of lesson specifications.

j. Criterion Test Statement - A statement of the conditions under which the SBO should be performed or demonstrated. It also includes the associated standard of performance which must be achieved in order to ensure the SBO behavior when in the operational situation. Whereas the SBO statement implies 100% standard of performance (in a single trial) the criterion test demands repeatability of behavior at a certain level as demonstrative that behavior is indeed "learned".

k. CT Number - Similar to the SBO number, a unique numerical identifier.

l. Test Type - A preliminary and general classification of the suggested form which the criterion test might take. Typically subdivided into either written, oral or demonstration tests, conducted in a classroom, in the A/C or in a simulator. More definitive recommendations are made following completion of the Media Analysis.

m. Test Format - This section of the SBO/CT form is completed as part of the Media Analysis and used during sequencing of instructional blocks.

As one looks at the record sheet, it becomes obvious that it deviates slightly from the conventional method of structuring an SBO. The Criterion Test Statement has been deliberately separated from the SBO statement. This was done to accommodate the fact that a performance measurement could not always be accomplished under operational conditions/constraints and to the operational standards. For example, the performance of a malfunction procedure in an operational environment and to operational standards is just not feasible in an A/C. Therefore, this type of performance measurement is conducted in a WST where the malfunction can be simulated and the performance evaluated to the standards dictated by the capacity or limitations of the simulation. Another consideration was the confidence level instilled in the instructor as a result of a student performing a task only once to the operational performance standards. For the instructor to have confidence that the student will meet or exceed the minimum operational standards in the fleet, he must witness that the student has met or exceeded the standards considered appropriate at the Readiness Squadron level of training a bonafide number of times during the criterion test. So, although the format deviates slightly from the standard method of writing the SBOs, it presents all the characteristics and still allowed enough flexibility to incorporate learning conditions, constraints, and performance standards where necessary.

In the next step of the process, pilot and B/N job-related behaviors were specified as a result of an in-depth analysis of the Task Listing and then integrated with the related training factors previously identified in the Task Analysis to formulate SBOs. The high-level behaviors i.e., behaviors that replicate or closely resemble the task were identified first by analyzing the activities task by task and step by step. These behaviors formed the substance of subsequently constructed TOs. In turn, these high-level behaviors were analyzed to identify prerequisite behaviors which must be learned prior to being able to exhibit a high-level behavior. These behaviors constituted the substance of subsequently constructed EOs. At this time, a previously recognized problem, lack of documented standards, had to

be resolved. Realizing that the terminal objectives from prerequisite training programs were not available in accessible documented form, the SME team members agreed to identify, as best they could, the entry levels for the Readiness Squadron pilot and B/N. Immediately after the job related behaviors were identified for a particular task of the Task Listing, they were combined with the appropriate information gathered on the Task Analysis Record Sheet to formulate terminal and enabling SBOs and associated criterion tests. All of this SBO data was recorded on the Instructional Systems Design Record Sheets and placed in an objective hierarchy. In all, 373 SBOs were identified; 109 were identified for the B/N, 105 for the Pilot and 159 for the Pilot and B/N. Once the SBOs were developed and recorded, a review was conducted by VA-42 and VA-128. Their comments were primarily concerned with relaxing the performance standards. They did not provide any negative comments with respect to the adequacy or applicability of the SBOs. Following this review the SBOs were used in the development of the Lesson Specifications.

MEDIA ANALYSIS

INTRODUCTION. Media selection is the principal factor in determining how instruction is to be packaged and presented to the student. The selection of media affects both the cost and effectiveness of training. The first consideration relative to media is whether or not any media are required. Ideally the A-6 pilot and B/N could be completely trained on-the-job, with only the aircraft and operational facilities and documents as aids. A brief examination of the reality of the situation reveals that this can not be the case. There are practical considerations related to cost, safety, and the availability of aircraft that constrain the exclusive use of operational resources in the aircrew training program. There are also instructional considerations such as ensuring student proficiency in emergency/malfunction situations, most of which would not occur in the "normal" environment.

Therefore, alternatives to the operational aircraft must be considered. A systematic approach to the Media Analysis required a consideration of the following factors related to the objectives: the skill/knowledge category of each group of objectives, the instructional requirements of each objective, an understanding of the stimulus characteristics of the various media alternatives, a selection of media mixes that have the needed characteristics, and finally an analysis of the cost factors associated with the media alternatives.

THE PROCESS. The media analysis began with an examination of the Specific Behavioral Objectives (SBOs), at the terminal and particularly at the enabling level. This examination had the purpose of identifying the various activities and kinds of learning involved, such that appropriate media satisfying the characteristics of that learning might be identified. During the examination it became obvious that the SBOs as written often required a lower, more detailed level of treatment in order to ascertain appropriate media. These more detailed statements were entitled Learning Points. These learning points were merely another cut in the tier of enabling objectives, and were so converted and labeled when the lesson specifications were prepared.

A review of ISD reference documents[1-4] revealed a commonality of approach in the identification of media characteristics. The various forms differ, as do the number of variables, but the process is essentially the same. The primary reference during the Media Analysis phase has been the work of Boucher, Gottlieb and Morganlander, Handbook and Catalog tor Instructional Media Selection[4].

A preliminary step in the media selection process involved the analysis of objectives/learning points to determine the information to be provided the learner and the behavior expected of him. This was done by considering the media requirements for three phases for each objective/learning point; (1) Initial Instruction (2) Practice; and (3) Demonstration/Test.

The following questions were then asked, with respect to each phase separately: (1) what are the essential stimulus characteristics necessary to present the material; and (2) what capabilities are required for optimum student response? Initially, these questions were addressed using the Media Capabilities Work Sheet from Boucher, et al. (see Fig. 6). It became apparent, however, that the "universal application" nature of this worksheet caused a number of considerations to be addressed that were not appropriate for this stage of the study. These considerations, premature in nature, were found primarily in the Instructional Strategy section of the worksheet. It was also found that some of the presentation characteristics were not relevant to this study. For these reasons the worksheet was first revised, and then put aside in favor of a simplified Media Analysis Table (see Table 4).

In the Media Analysis Table, SBOs (left-hand column) possessing similar learning outcomes have been grouped together (a first step in the blocking process). Each group of one or more SBOs is separated by a horizontal line across the page. Next to each SBO group are one or more learning points associated with all of the SBOs of the group. To the right of each learning point are the media devices selected for presentation and use for the three learning phases (initial learning, practice, demonstration/test), to meet the educational requirements of the learning point and in turn, the SBOs in the group. It should be noted that the mental process of assigning media to each of these phases was a continuation of the thought processes begun with the Media Capabilities Worksheet (Fig. 6) although the worksheet itself was no longer used. In the column labeled Initial Learning are the media devices used for presentation of material to the student as required by the learning points. The devices used to reinforce and practice the newly learned skills are listed in the column labeled Practice. The entries in the Demonstration/Test column are the media used for the criterion test of the learning point.

Media Classification and Results. The summary tables showing the results of the media analysis have been organized by categories much in accord with the classification grouping shown in AFP 50-58, Handbook for Design of Instructional Systems, with the notable

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1 Dept. of Air Force, AFM 50-2 and AFP 50-58, op. cit. p. 12.

2 Training Analysis and Evaluation Group, An Evaluation of Ten Techniques for Choosing Instructional Media, Orlando, Fla., Report TAEG No. 8, Dec. 1973.

3 U.S. Training & Doctrine Command, op. cit. p. 48.

4 B. G. Boucher, M. J. Gottlieb and M. L. Morganlander, Handbook and Catalog for Instructional Media Selection, Educational Technology Publications, Englewood Cliffs, N.J., 1973.

MEDIA CAPABILITIES WORKSHEET	Presentation													Stud. Response					Instruct. Strategy						
	Visual							Auditory		Tactile				Verb Symb		Performance			Feedback			Interaction			
	Plane (2D)	Solid (3D)	Locality (3D)	Motion, Full	Motion, Ltd. Excur	Motion, Conceptual	Color	Quality	Locality	Size/Shape/Texture	Temperature	Motion	Kinesthetic Cues	Selection	Created	Indication	Manipulation	Gross Body Movement	Informative	Evaluative	Corrective	Linear	Branching	Adaptive	Repetitive

Figure 6. Media Capabilities Work Sheets (Preliminary)

TABLE 4. MEDIA ANALYSIS TABLE
(VOLUME I)

SBO GROUP	LEARNING POINTS	INITIAL LEARNING	PRACTICE	DEMO/TEST	QUALIFYING REMARKS
380 Cont'd	2. Familiarize use of A-6E takeoff and landing cross wind charts	Checklist, printed mat'l, sound slide/carrel			
390	1. Control and maneuvering of A/C during takeoff		WST, A/C		
	2. Use of takeoff charts	Printed mat'l (NATOPS)			
340 - 390	1. Practice takeoff		WST	A/C	
390.1	1. Knowledge of nominal and off-nominal conditions and knowledge of appropriate response	Printed mat'l, video tape/carrel			
	2. Recognition of off-nominal condition and taking appropriate corrective action	WST	WST, Proced. Trnr. (6)	WST	(6) Procedures Trnr. for T1-T7
400	1. Variation from normal A/C lighting conditions for night carrier operations	Checklist	A/C	A/C	

differences given in the following category breakdown. Only media for which a requirement was identified are shown in the tables. Thus, whole and part task trainers, opaque projections, teaching machines, and other media from AFP 50-58 are not illustrated.

a. Graphics Media Category - Inclusions in this category have been restricted to instructor employed aids, such as, wall charts, oversized system diagrams and cockpit layout drawings. Other graphic materials have been included either under the audio visual category, if projected, or within the printed media category, when student utilized, e.g., photographs, illustrations/drawings, charts, graphs, checklists, etc.

b. Printed Media Category - Although separately identified in the media analysis tables found in the media analysis document [1], and relating media to SBO groups, it has been excluded from the summary tables contained herein. It is assumed that this category of media will be available as required e.g., NATOPS FAM and TAC manuals, checklists, lesson/study guides, etc.

c. Tutorial Media Category - Carrels have been added to this category.

d. Environmental Media/Aids Category - A specific media subset, encompassing features of both games and role playing aids of AFP 50-58, called paper simulation, has been identified as a useful tool for "headwork" assessment of mission planning and in-flight mission decision-making. Paper simulation is discussed further in the paragraphs providing a functional description of the candidate devices found in this report.

e. Operational Equipment Category - This category, which includes the A-6E aircraft and the TC-4C trainer has been added to the media classification.

Tables 5 and 6 provide summaries of the media analysis. Tables containing the detailed media analysis data are found in the Appendix section of the Media Analysis Report. Table 5, SBO count per media type, indicates the number of SBOs in the training program for which the use of different types of media is recommended. Volume I refers to SBOs identified for pilot training for normal operations; Volume II refers to B/N normal operations; and Volume III refers to Pilot and B/N Emergency Procedures and Weapon System Failures. In the main, the same media are used to the same extent for both pilot and B/N training. The principal items are sound slide projections and overhead transparencies, WST and Procedures Trainers. Pilot training SBOs reflect a higher proportion of the use of the A/C as a medium than do the B/N SBOs. These in turn employ the TC-4C trainer for certain weapons system operations which cannot be trained in the A/C or WST because of instructional considerations or capability limitations. Since the A-6E TRAM ISD program emphasizes operational considerations, the use of simulated or operational equipment is highly desirable, and is so reflected in the media recommended.

Since the weapon system operations involve a considerable amount of radar scope interpretation and FLIR imagery changes, the use of 16 mm film and video tape as a training media tool is emphasized for B/N training.

Table 6 summarizes the use of media, again related to SBOs, for three phases of training: the initial learning phase (IL) which includes much of the basic familiarization training as well as some skill development, the practice phase (P) in which skills and knowledges are refined and improved, and the demonstration or test phase (D/T).

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[1] Feddern, et al., Report ISD (SAT) 0004, op. cit, p. 31.

TABLE 5. SUMMARY OF SBO COUNT PER MEDIA TYPE

Media	Volume I	Volume II	Volume III	Total SBOs
Transient Media				
• Audio Visual -sound slide projector	52	56	58	166
-live TV	4	0	0	4
-video tape	36	49	4	89
-16 mm film	3	49	12	64
Visual Aids				
• Graphics -wall charts	10	47	0	57
• Exhibits -mockups/models	5	0	0	5
• Projected Images -overhead transparencies	67	53	58	178
-slides	0	12	0	12
Tutorial Media				
• Carrel	30	66	43	139
Environmental Media/Aids				
• WST	71	75	89	235
• Procedures Trainer	37	48	43	128
• Paper Simulation	*	*	*	
Operational Equipment				
A/C	92	58	11	161
TC-4C	0	15	0	15

TABLE 6. SUMMARY OF MEDIA COUNT BY INSTRUCTIONAL PHASE

Media	Volume I IL	P	D/T	Volume II IL	P	D/T	Volume III IL	P	D/T	Total IL	P	D/T
Transient Media												
• Audio Visual -sound slide projector	53	3	1	51	24	0	58	0	0	162	27	1
-live TV	4	0	0	0	0	0	0	0	0	4	0	0
-video tape	38	1	1	49	12	0	4	0	0	91	13	1
-16 mm film	3	0	0	49	0	0	0	0	12	52	0	12
Visual Aids												
• Graphics -wall charts	10	0	0	47	0	0	0	0	0	57	0	0
• Exhibits -mockups/models	4	0	1	0	0	0	0	0	0	4	0	1
• Projected Images -overhead transparencies	67	2	1	53	0	1	58	0	0	178	2	2
-slides	0	0	0	0	12	0	0	0	0	0	12	0
Tutorial Media												
• Carrel	31	2	0	40	46	0	44	0	0	115	48	0
Environmental Media/Aids												
• WST	17	68	12	5	74	51	11	90	82	33	232	145
• Procedures Trainer	3	37	0	0	48	0	22	43	0	25	128	0
• Paper Simulation		*			*			*			*	
Operational Equipment												
A/C	11	69	83	0	33	58	0	11	0	11	102	141
TC-4C	0	0	0	0	11	14	0	0	0	0	11	14

Here again, the media recommended for both pilot and B/N training are almost identical. As would be expected, a dramatic transition from use of audio visual and other visual aid media in the initial learning, to the environmental media and operational equipment during the practice phase, is indicated. Because of the fact that the A-6E weapon system is new to the replacement B/N, considerable individual practice using a carrel is seen in the initial learning phase and continuing into the practice phase of training. The procedures trainer is recommended to support some initial learning/training in nominal and emergency procedures, but is used predominantly for practice of airframe emergency procedures for the pilot and for off-nominal or alternate weapons system procedures for the B/N. It is not recommended for use in the demonstration or test phase of training.

Functional Description of Candidate Devices. The media analysis resulted in the identification of a number of candidate devices which will provide the training support desired in satisfying the totality of training objectives. Candidate device selection followed upon completion of a survey of devices in inventory, particularly those units available within VA-42 and VA-128, Readiness training squadrons, and those which might be obtained from audio-visual manufacturers. Findings of the field site survey are reported later in this section.

Further, the survey continued with an analysis of the A-6E Weapons System Trainer (WST) and the A-6 Suitcase Emergency Procedures Trainer (SCEPTR) with regard to existing configurations and desired modifications.

Nine categories or classifications of media devices were identified and recommended for use in the training program. They are:

- Procedures Trainers (PT)
- Paper Simulation
- Sound-Slide Devices
- Video Tape Player Devices
- 16mm Motion Picture Devices
- Overhead Transparency Projection Devices
- Learning Carrels
- Weapon System Trainer (WST)
- TC-4C Inflight Trainer

In addition the use of the A-6E aircraft in a training mode is considered a primary element of the training program.

The media analysis report[1] includes a series of data sheets providing generic, categorical descriptions of the audio visual devices, functional descriptions and pricing

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1 J. Feddern, et al., Report ISD (SAT) 0004, op. cit., p. 31.

data for specific items. The data sheets for the remaining media devices (PT, WST, TC-4C and paper simulations) provide functional descriptions with preliminary pricing information indicated for the B/N Procedures Trainer. They are considered sufficiently important to an appreciation of the conclusion drawn from the media study to include the essentials of those data sheets herein.

Procedures Trainers. Reference to the summary tables (Tables 5 and 6) shows that there are at least 153 instances where the intersection of B/N or pilot teaching strategies and SBOs warrant early procedures training. Presently the only device planned or available that can satisfy these requirements is the WST. In consideration of the hi-fidelity flight simulation capability of the WST and its intended use in the overall A-6 flight crew training program, application of this device for initial procedural familiarization, either nominal or emergency, or early development of cognitive skills appears to be an inefficient utilization of this resource.

Consequently it is recommended that both a B/N Procedures Trainer and a Pilot Procedures Trainer be included in the media inventory to fill the gap between classroom instruction and hi-fidelity integrated weapons system training or pilot flight related activities. The Trainer would be used for reinforcement of concepts of operation, initial development of related display and control operational skills, and procedural drills involving assessment of airframe emergencies, assessment of weapons system configurations and subsequent selection of optimum alternate or secondary paths for off-nominal conditions. The latter application involves early development of skills in the cognitive domain for one of the most essential objectives in the B/N training program, i.e., the recognition and assessment of the pertinent parameters affecting a weapon delivery and the selection of the correct response for subsequent action based on these parameters.

The Procedures Trainer (PT) should include the following major features:

a. A replica of the B/N (or pilot) displays and controls, including any pilot displays directly affected by B/N action.

b. A minimum set of simulated CRT displays to reflect significant display responses to B/N (or pilot) actions.

c. A capability to handle a repertoire of part- and full-mission-oriented procedures.

d. A means to quickly set up initial conditions, hold action or change runs.

e. A training-oriented interactive system consisting of an error recognition system, response system, timers, counters, etc.

f. Capability to randomly introduce conditions requiring timely assessment and implementation of the most correct course of subsequent action.

g. Portability and easy setup using conventional power supplies and training facilities.

h. Capability to easily reconfigure the trainer and its scenario sets.

i. Ease of maintenance.

j. High reliability

As an example of the technology that is available for this type of device, emergency procedure trainers currently being manufactured by Grumman (generically known as Suitcase Emergency Procedures Trainers-SCEPTR) conceptually incorporate many of the features recommended for the A-6 Procedures Trainers. The SCEPTR units are portable, can be rapidly set up and are capable of operation in a train or quiz mode. Train mode enables the student to attain proficiency in emergency procedures. The quiz mode gages his progress.

Using the Tasks and SBOs selected as candidate material for a PT program, an examination was made into the possibility of expanding the basic SCEPTR concept to include the capability required for a B/N or Pilot PT. It has been concluded that the basic concept satisfies the requirements of a Pilot PT. In the case of a Pilot PT the procedural aspects of operating the A/C are more straight-forward and can be keyed directly from approved nominal and emergency checklists. Consequently, the current SCEPTR design, including the addition of a random failure mode, need not be altered appreciably. Less capacity would be required for sequential or alternate path routines and therefore considerably less non-recurring programming time.

The major efforts involved in expanding the concept for a B/N PT concern the following points:

a. Inclusions of Simulated CRT Presentations for the VDI, DVRI, and FLIR Indicators - A selected number of pertinent displays could be projected onto a screen and when necessary could simulate motion with sufficient fidelity to accomplish the overall learning objective.

b. Expansion of the Present 6K Memory to 16K or Greater - As a result of expanded switch and display requirements and the inclusion of sequentially oriented nominal and off-nominal mission routines, storage tables would be larger and the present size of the executive program would have to be significantly increased to accommodate management of the required algorithms.

c. Simulation and Replication of the Computer Keyboard and Displays - LEDs could be used to display data feedback for a selected number of items, such as, the temporary storage register display (in lieu of rotating drums or tape drives). Other data displays could be limited to predesignated values or covered by advisory displays to minimize storage requirements.

d. Inclusion of A Selectable Random Failure Routine - A recognition mode of operation is currently being designed for incorporation into a helicopter SCEPTR. When activated, a system configuration is displayed resulting from a randomly injected failure condition at a discrete time. A display then offers the student a choice of up to eight diagnoses and sets a routine to enable and monitor the alternate routine.

Including the expanded capability of the recommended A-6 PT, the hardware costs would not significantly increase over the hardware cost of the presently available SCEPTR. However, a considerably higher nonrecurring programming cost would be incurred for the B/N PT.

Weapon System Trainer. The Media Analysis has identified 235 SBOs that can best be accomplished on a Weapons System Trainer (WST). Of these SBOs, 146 are related to nominal pilot and B/N tasks while the remaining 89 are related to Airframe Emergencies and System Malfunctions.

An A-6E Weapons System Trainer, Device 2F114 (incorporating the requirements stipulated in NTEC Specification 2221-1133A, 16 Sept. 1974, Task 4062 and supplemented by TRAM characteristics) will satisfy these SBOs. These requirements call for a trainee station (i.e., simulated side by side pilot and bombardier/navigator cockpits) with its associated instructor station having input/output controllers and conversion units. These equipments will be activated by a general purpose digital computer system. A Digital Radar Landmass Simulation (DRLS) System should be provided with each trainer unit. The trainer should be capable of simulating normal, emergency and degraded operation of the A-6E aircraft including aircraft control, instrument procedures, airframe system and engine control, emergency procedures and all modes of weapons systems operation and delivery. Close coordination between the pilot and B/N is provided during all aspects of simulated A-6E operation. The following is a brief description of some of the more important aspects of the A-6E that should be simulated:

a. Aerodynamic performance and flight characteristics.

b. Simulated motion of ownship with respect to any geographical location from sea level to 50,000 ft.

c. Power Plant Systems - Throttles, ignition system, CSD, engine oil system, engine bleed air system, engine instruments, engine fuel control system.

d. Primary Aircraft Systems - Aircraft fuel supply system, fuel quantity indicating system, hydraulic power supply, system flight controls.

e. Auxiliary Aircraft Systems - Automatic flight control system, automatic carrier landing system, approach power compensator, speed brakes, landing gear system, nose-tow catapult system, wing fold system, wheel brake system, arresting hook system.

f. Flight Instruments and Indicator Lights - Angle of attack system, pitot static system, MA-1 compass system, HSI, radar altimeter system, caution, warning and advisory lights.

g. Canopy - Canopy switch, switch caution light, manual canopy handle, boarding ladder switches, auxiliary hydraulic pumps, hand pump, electric motor driven pump, a solenoid thumper indicating successful canopy jettison, canopy de-fog system.

h. Lighting Systems.

i. Communication, Navigation and Instrumentation System (CNI).

j. Attack Navigation Systems - Search Radar and indicators, Inertial Navigation System (INS), Doppler Navigation System, Pedestal Control Unit, Digital Display Unit, Air Data Computer. The On-Board Computer, AN/ASQ-155, is an actual operational computer.

k. Systems Displays - Direct View Radar Indicator (DVRI), Pilots Control Box (PCB), Vertical Display Indicator (VDI), Optical Sight, Forward Looking Infrared (FLIR) Indicator, Sidewinder, Shrike and ECM displays including aural tones.

l. Weapon Release System - Armament Control Unit, fuze function control panel, nuclear panel, manual release buttons, reselect logic, stores jettison, weapon mounting simulation, Ballistics Control Panel, Detection and Ranging Set (DRS) including laser and Forward Air Controller ranging and control functions.

m. Fire Detection System.

n. In-flight Refueling System - Simulation limited to cockpit functions.

o. Electronic Countermeasures (ECM) - Active and passive ECM capabilities, chaff dispensing.

p. Built-in Test (BIT) Systems.

There are certain A-6E capabilities that are not simulated in the currently planned WST update. One example is A-6E VFR shore and carrier landings. If the expanded WST had a visual land mass simulator and some other minor refinements, the pilot could practice VFR operations. In addition, this modification would allow the use of the optical sight for navigation checks (COP) and visual attack modes. Another shortcoming of the currently planned WST is its static FLIR display. Many of the tracking and attack procedures require the use of FLIR imagery which does not and will not exist on the WST display.

Our analysis has shown that a considerable number of specific behavioral changes associated with these visual operations would best be achieved through training in a WST.

TC-4C Inflight Trainer. As a result of the media study, 15 Specific Behavioral Objectives (SBOs) have been identified that can be performed in a TC-4C aircraft. All of the objectives are related to navigation and system steering using the Search Radar and the 4 π Computer.

The TC-4C is a modified Gulfstream that is equipped with a radome, and an A-6E configured cockpit in the cabin with several B/N repeater stations. It is primarily a B/N training device used to teach the techniques of navigation, target acquisition and target tracking under actual flying conditions. Although the introduction and some of the practice phases of many of the SBOs might be satisfied in the WST, the TC-4C provides valuable in-flight demonstration of the capability of the B/Ns to use the operational equipment under actual flight conditions. The multistation capability also provides simultaneous training of 2 to 3 B/Ns. A Grumman proposal has been submitted to the Navy to retrofit an existing TC-4C aircraft with a Detection and Ranging Set (DRS). If this proposal is accepted and the retrofit is accomplished, the target acquisition and tracking procedures using FLIR imagery can be practiced and demonstrated under actual flying conditions.

Paper Simulation. Throughout this study, the Navy SME/Pilot and B/N Instructors have made repeated reference to something called "headwork". After much discussion, the following operational definition of this term was developed: "The ability to perform in a satisfactory manner in situations for which one has not been specifically trained." The evaluation of "headwork" is currently done in the A-6 Readiness Squadron. It is found as a line item on many flight rating forms.

As an aid in developing, recognizing, and measuring "headwork" in the nonflight environment it is felt that the category of media called paper simulation could be effectively utilized. Paper simulation is the representation of selected dynamic characteristics of a system through the use of charts, tables, static photographs, drawings and lists of performance characteristics under specified conditions. This information is presented in such a way that the trainee can study the initial performance of the system, change inputs to, or elements within the system and note changes in the performance of the system. It should be noted that although paper simulations are not a part of the current flight crew training syllabus, they are being used successfully in other areas, notably management training. They have proven effective in providing both practice and measurement of the higher order mental skills involved in planning and decision making.

It is felt that simulations of this type could be developed for mission planning and mission contingencies. The learners would be given certain information, some relevant, some not, and asked to make decisions which would affect the planning and carrying out of the mission. This could be done on an individual basis or in groups to enhance the competitive aspects of the exercise. At the appropriate point in the exercise, the learner is brought face to face with the results of his earlier decisions. This technique could be effectively used in enhancing and measuring the decision-making aspects of the job of aircrewman in areas such as target and route planning, ordnance selection, fuel planning, alternate mission planning etc. It can also be used to introduce unplanned, but "real" contingencies to the nominal "simulated" mission. The student's response to unforeseen changes in weather, target priority, enemy defenses, and A/C or systems operation can be observed and critiqued.

The paper simulations can be prepared and stored for use at the instructor's discretion. If done realistically, they can add an enriching element to the more traditional syllabus.

MEDIA SURVEY. As part of the media selection process a field site survey of media currently in VA-42 and VA-128 inventory was conducted. Selected media devices found to be already in inventory were examined as to their inherent capabilities to satisfy the SBO/learning points associated with them. The devices examined were those which are for learner use, such as carrels, video players, sound slide devices, etc. Other equipment, such as portable video recording systems, studio video systems, audio tape copiers, etc., were recognized as production or development devices and accordingly outside the considerations of being appropriate for learner use and therefore not included in the analysis.
the analysis.

The survey revealed a significant disparity in the media resources of the two training squadrons. VA-128 has an extensive inventory of television equipment consisting of a studio and portable recording system, including a special effects generator, studio type video recorder, six color monitors (suitable for classroom use) as well as lenses, camera stands and tripods, lights and microphones. In addition, there are six video cassette players, one video cassette recorder and six T. V. receivers (suitable for carrel use). Furthermore, VA-128 has 12 study carrels, six Synsor LEM models and six Howe T/E-SS & T/E-SA with six Howe rear screen projection units for individualized multimedia learning. The audio-visual devices include six, 35mm slide projectors and eight Telex sound-sync audio players, a Telex audio cassette copier, two 16mm projectors, a stereo audio recorder and twelve headphones. It is apparent from this survey that VA-128 is relatively well-equipped for meeting the media candidate requirements identified in this report.

Although VA-128 has an extensive inventory of equipment there exists, for them, the problem of: (1) assembling and configuring the learning carrels for optimum utilization of equipment and facilities; and (2) the training of selected instructor personnel in the use of multimedia devices.

VA-42 squadron has a severely limited media capability. Their inventory consists of the following:

- Three overhead projectors
- Three slide projectors
- One rear projection sound-slide device
- One 16mm projector (reel-to-reel)
- Three tape recorders (not suitable for making or reproducing tapes for the sound-slide device)

A comparison of the limited VA-42 inventory with the training support requirements stated in the report reveals the need for the purchase of the following equipment:

- Learning carrels
- Sound-slide devices
- Video cassette players
- Headphones

Except for headphones, specific equipment could be selected from the data sheets contained in the Training Support Requirements document. (1)

INSTRUCTIONAL STRATEGIES AND SEQUENCES

INTRODUCTION. Lesson Specifications for A-6E (TRAM) replacement pilots and bombardier/navigators were developed by the Navy/contractor ISD Team. The primary data sources used in the preparation of these Lesson Specifications were the Instructional Systems Design Records, which contain the Specific Behavioral Objectives and their associated Criterion Tests, and the Media Analysis Tables from the Training Support Requirements Document.[1]

Following the completion of the Media Analysis, the first step in the process of developing the Lesson Specifications was to analyze the SBOs to determine those which were independent of each other, those which were dependent and those which had supportive relationships. When two SBOs are independent, the learning of one has no effect on the learning of another. When two SBOs are dependent, it is necessary to learn one prior to learning the other. The third possibility exists when the learning of one SBO supports or facilitates the learning of another, but the order in which they are learned is not important. The learning in one will transfer to the other no matter which one is learned first. The outcome of this process is a learning heirarchy which forms the first firm determinant of the sequence of instruction to be followed in the training program.

In actually performing this analysis it became apparent that many of the dependent relationships were already identified within the terminal-enabling SBO structure. That is, most terminal SBOs had enabling objectives tied to them by SBO number and location, within the three volumes of SBOs. The learning of the enabling SBOs was, quite naturally, placed before the terminal SBO. The remaining portion of the task, that of sequencing the terminal SBOs, was found to be more complex because of the high incidence of supportive and independent SBO relationship.

The relative lack of firm hierarchial dependent relationships among terminal SBOs led to the consideration of instructional sequencing based upon context: either "systems" or "phase of flight". It was recognized that there is an instructional advantage to introducing the system e.g., location and operation of controls and the necessary concepts for initial operation of the system while allowing the trainee to interact with the hardware as soon as possible. That this active participation must occur within the correct context of phase of flight in order to establish a valid framework of associations led to the strategy of integrating "systems knowledge" with actual "systems operation". The use of the Procedures Trainers, the WST, and the TC-4C allows the application of this instructional strategy without risking lives or aircraft in the early learning stages. The task of sequencing the terminal SBOs became one of integrating the procedural "systems operation" objectives with the "systems knowledge" objectives in an order which reflects, as closely as possible, the operational sequence of events e,g., teach preflight activities before tactics.

The Training Support Requirements Document[1] lists seven learning principles or guidelines which have been identified as applying to the training of A-6E/TRAM crewmen. The first stated the desirability of providing early hands-on practice and has been discussed.

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[1] J. Feddern, et al., Report ISD (SAT) 0004, op. cit. p.31.

Of the remaining six guidelines, four were found to have significant impact on the design of the Lesson Specifications. They are:

a. Task integrity and continuity should be preserved wherever appropriate in training.

b. The principles of mass versus distributed practice should be considered throughout the program.

c. Tasks requiring considerable skill development should be introduced and practiced early in the program.

d. Maximum transfer of training skill and knowledge to the operational environment can be achieved with maximum use of "real" hardware.

The first three guidelines are functions of sequencing and blocking. That is, success or failure to implement these guidelines depends upon the order in which SBOs are sequenced for instruction, the grouping of SBOs to be taught together, the duration of instructional blocks, and the duration and spacing of practice periods. Success in implementing the fourth guideline is determined by the decisions made in assigning media to newly grouped blocks of SBOs. (This often involves compromises between the optimum media assigned each individual SBO during the media analysis).

In addition to the consideration of learning guidelines during the formulation of the Lesson Specifications, there are three operational characteristics of the SBOs themselves which can come into play in determining the durations and sequencing of instructional blocks. These characteristics are:

- Difficulty (both to perform the required behavior and to learn it)
- Criticality
- Frequency of Occurrence

The amount of time allocated to teaching and study/practice of a given SBO is directly related to the degree of difficulty in performing or learning that behavior. The Task Analysis Record includes ratings of task difficulty along with a checklist of difficulty factors i.e., the reasons for a task being difficult, such as - limited time or number of cues available. Experience shows that while the Task Analysis Record points to behaviors which pose difficulty to the student, the judgments of the SMEs are invaluable in qualifying these difficulties and quantifying the time generally required for instruction and practice/study.

Criticality of an objective influences the training time in that if an objective e.g., engine failure emergency procedure, has high criticality with respect to crew safety or mission success, training time must be sufficient to ensure that the trainee can accomplish the objective. If the objective is not crucial, then less training time is appropriate. The Task Analysis Record contains entry locations for criticality which were helpful in developing the Lesson Specifications. These entries cover the range from no criticality, through Degraded Mission, to Crash/Death.

The third operational characteristic which was particularly considered in developing the specifications was that of frequency of occurrence. If the frequency of the event is

"high" the behavior required to handle the event must be trained and the time allocated for training that behavior must be ample. The criteria of "high" frequency is not clearly defined, although the Task Analysis Record addresses it under the heading of Specific Training Factors with entries such as "Normal Recurring" and "Requires Frequent Practice". Once again, the judgement of operational personnel, in the person of Navy SMEs, was required.

PROCESS. The task of analyzing the SBOs in preparation for sequencing and blocking began with the physical separation of the SBOs from the three volumes of SBO Statements[1], and their rearrangement into two groups, one for the Pilot and one for the Bombardier/Navigator. The determinant factor for this division was the "Task Responsibility" box of the Instructional Systems Design Record (Fig. 5). Tasks designated for only the Pilot or B/N were placed in their respective groups, while tasks identified as "both", "shared", or "coordinated" were placed in both groups. This division was necessary because the Pilot and B/N documents contain SBOs describing behaviors performed by the other crewman. This is an evolution of the "Mission Scenario" format of the Task Listings, i.e., all pre-flight, takeoff and landing related tasks are in the Pilot volume, all tactics and weapons delivery tasks are in the B/N book. With all SBOs now sorted by crewman responsibility, individual contractor ISD team members were assigned to each of the two sets of SBOs and proceeded with the processes of developing Lesson Specifications for each crewmember.

The task of analyzing the SBOs prior to sequencing and blocking was handled slightly differently by the ISD team members. In the case of B/N SBOs it was found that system/subsystem associations predominated and therefore a grouping of SBOs by system/subsystem e.g., Air Data Computer, Detection and Ranging Set, etc. was found to be useful and appropriate. Informal summary worksheets were used to sort the SBOs by systems/subsystem. These worksheets also included checkoff boxes for a variety of operational and training characteristics, such as, difficulty, criticality, and frequency. The data sources for these worksheets were: the Task Analysis Records, the Task Listings, and the SBOs themselves. The outcome of the initial use of these worksheets was the division of B/N SBOs into seven groups of activities, i.e., Familiarization, System/Subsystem Design, Theory and Application, Airframe Emergencies and System Malfunctions, Navigation Theory and Application, Attack Theory and Application, Air/Combat Theory and Application, and Takeoff and Landing Checks.

The pilot SBOs were found to be less associated with systems/subsystems than with phase of flight and phase of mission. For this reason it was deemed appropriate to annotate the SBO Record Sheets themselves with the operational and training characteristics. This data was taken directly from the Task Analysis Records which in themselves are mission/phase of flight oriented. The group of Pilot SBOs was then physically sub-divided into six groups with the following titles: Familiarization, Visual Weapons Delivery, Tactics, Navigation, System Weapons Delivery, and Carrier Qualifications. These first groupings of both pilot and B/N SBOs were designated as Training Phases. The phases were then further divided into units consisting of either systems related or phase of flight related SBOs. The phases and units were in themselves blocks of instructional requirements, with the ordering of units within the phases suggesting the first sequencing of instruction. The educational specialists performing this first and second level blocking and sequencing were influenced by the learning guidelines as well as the analytical data relative to each SBO.

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[1] Grumman Reports 1SD (SAT) 0003-4, 5 and 6, op. cit. p. 45.

With the SBOs divided into phases and units, the next step was a review by the SMEs from VA-42 and VA-128. This took place during a three-day working conference at NAS Oceana. The major activity at these meetings was an in-depth examination of the content of the phases and units in light of the practical experience of the SMEs as Pilots and B/Ns, and as instructors in an existing A-6 Readiness training program. The SMEs were able to point out a number of practical or operational considerations which suggested changes in the phases and units, e.g., Navy minimum flight hour requirements prior to tanker operations and carrier qualification. They also assisted in the identification of specific lessons within the units and provided estimates of time for Initial Learning, Practice/Study, and Demonstration/Test based on their experience as students and instructors. Two significant observations were made by the SMEs during these meetings:

a. The bulk of the aircraft systems training for the current A-6 Readiness Training program is done by the Naval Air Maintenance Training Group in highly concentrated form prior to any Readiness squadron hands-on training. It was felt that much of this training was not retained because it was not associated with operational activities. This was especially true in the case of Replacement B/Ns, who do not even have the aircraft operational experience of the Replacement Pilots, at least 18 months experience in the Training Command.

b. The current Readiness Squadron training program includes replacement B/Ns in basically the same Familiarization Phase as the Replacement Pilots at the beginning of the program. The goal is to prepare the RBNs to function as copilots. Again, the RBNs do not have the same entry level skills and knowledges as the RPs and much of the training is not retained. The SMEs were unanimous in their opinion that the bulk of the real learning on the part of BNs, in the areas of aircraft systems operation and copilot activities, took place in the operational squadrons.

Based on these considerations, the following instructional strategies were recommended:

a. The aircraft systems training currently being done by the Maintenance Training Group, should be done in the Readiness Training program as part of the Familiarization Phase. Furthermore, the content of that training should reflect an operational rather than a maintenance orientation.

b. The copilot training given the RBNs, including the relevant portions of the aircraft systems training, should be placed late in the Readiness Squadron RBN curriculum to allow greater association with actual flight operations.

At the conclusion of the meetings at NAS Oceana, the contractor ISD team proceeded with the preparation of Lesson Specifications. This process involved the following activities:

a. The units of instruction were further subdivided into lessons with SBOs identified and assigned to each. The sequence of lessons within the units, and units within the phases were finalized, based on their hierarchical interrelationships.

b. The phases and units of instruction were adjusted, based on the discussions with the SMEs. The seven preliminary B/N Phases were consolidated into four phases made up of a total of 10 units. It was decided that the familiarization and carrier qualification phases

of the B/N's program would consist of those portions (lessons) of the pilot program which contained B/N activities. The Replacement Pilot's training program would contain six Phases containing a total of 12 units. The Navigation and Target Acquisition and Weapon Delivery Phases of the Pilot's program would be made up of the lessons from the B/Ns program which contained Pilot activities.

c. The media to be used in each lesson was determined based on the recommendations made in the media analysis. As previously noted, this process involved the making of certain compromises with the optimum media previously assigned to individual SBOs. That is, the total group of SBOs in a lesson could include six different media recommendations from the Media Analysis. Practicality requires that this number be reduced by selecting a smaller group of media may not be optimum for certain of the SBOs in the lesson, e.g., a sound-slide program and printed handouts are the designated media for a lesson satisfying a set of SBOs which originally called for overhead transparencies, wall-charts, sound-slide program, printed handouts, video tape and 16mm film.

d. The lessons were (where it was appropriate) further divided into "sessions" based upon hierarchical and media considerations.

OUTCOME. As a result of the foregoing activities, specifications[1] for 55 lessons were developed with 19 designated for the pilot only, 17 for the B/N only, and 19 common lessons for pilot and B/N. A summary of lessons is presented in Appendix A along with their estimated times for initial instruction and projected hours of simulator utilization. The lessons were documented on Lesson Structure sheets (see Fig. 7) under the three headings of (1) Initial Learning; (2) Practice; and (3) Demonstration/Test. The Initial Learning boxes contain the SBO numbers that are being addressed in the lesson/session, a statement briefly describing the instructional outcome of the lesson/session, and a listing of recommended media for the instruction. In some cases, both primary and alternate media are specified. The practice boxes include a statement on the recommended method of practice/study, and a listing of primary and alternate media to be used. The Demonstration/Test boxes specify the media and methods to be used in either Demonstrations, (for psychomotor activities), or Tests (for cognitive activities).

In addition to the Lesson Structure Sheets each Lesson Specification includes the following information:

a. Lesson Number and Title - The lesson number consists of an alpha-numeric designator where the letters P, B or P and B indicate the crewmember for whom the lesson is intended. P indicates Pilot, B indicates Bombardier/Navigator and P and B designates the lesson for both. The first number in the series designates the phase of training, the second indicates the unit within the phase, and the third specifies the lesson within the unit. The title for each phase, unit and lesson is also provided.

b. Specific Behavioral Objective (No. & Statement) - The left-hand column consists of a listing of the SBO numbers that are being addressed in the lesson. A given SBO sometimes appears in more than one lesson. This is a function of phase of flight and system considerations.

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[1] G. Graham, and J. Feddern, Report ISD(SAT) 0005, op. cit. p.32.

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LESSON: P 1.3.3 NORMAL OPERATING PROCEDURES-
A/C GROUND AND AIR PROCEDURES

	INITIAL LEARNING	PRACTICE	DEMONSTRATION/TEST
SESSION 1	SBO- 220, 230.3; 240, 240.6; 250, 250.4; 270, 270.4; 280, 280.4; 290, 290.4; 310, 310.4; 320, 320.4; 330, 340, 350, 370, 380, 390; 2060.2 Know the Procedural sequence and system relationships for Pre-start; Engine start; Post Engine Start; Wing Spread; Point Checks; Pre-Taxi Checks; Taxi;	Method - Initial individual practice on P/T, further instructor supervised practice during WST-1.	Demonstration - Initial Instructor evaluation is made during fam phase WST flights. Actual flight evaluations are made throughout the RAG flight syllabus.
	(cont.) Pre-takeoff Checks/ and Takeoff. Media: Instructor introduces procedures using P/T and pocket checklist. He reinforces important systems relationships during the presentation of each procedure.		
SESSION 2	SBO- 450, 450.1; 560, 560.1; 590, 590.1; 600, 600.1; 640, 640.1; 770, 770.1; 780, 780.1; 790, 800, 800.1; 810, 810.1 Know the procedural sequence and system relationships for: After Takeoff Climb; Descent Checklist; Fuel Dump; Approach; Before Landing Checks; Hot Refueling; Post Hot Seat Check; and Engine Shutdown.	Method - individual practice on P/T, further instructor supervised practice during WST-1.	Demonstration - Initial instructor evaluation is made during fam phase WST flights, actual flight evaluations are made throughout the RAG flight syllabus.
	Media: Instructor introduces procedures using P/T and pocket checklist. He reinforces important systems relationships during the presentation of each procedure.		

Figure 7. Lesson Structure Sheet Sample

Next to each SBO number is the actual behavioral statement, just as it appears on the Instructional System Design Record. During the process of preparing Lesson Specifications, additional enabling SBOs were identified for the pilot syllabus. They are listed in the Lesson Specification Document.

c. Media - The media to be utilized in each lesson, and session within the lesson, are designated under the heading of: Initial Learning, Practice and Demonstration Test. In many cases there is a preferred set of media designated by the word PRIM, and a second choice indicated by the term ALT.

d. Lesson Duration - The section consists of an estimate of the time required for the replacement pilot or B/N to fulfill the three aspects of behaviorially based learning, i.e., Initial Instruction, Practice, and Demonstration/Test. The term "Practice" includes the activity of studying where it is appropriate.

e. References - This section consists of a listing of the primary resource documents to be used in the formulation of the detailed lesson material. It is anticipated that further references will be identified as lesson development continues.

At the time of this writing, comments from the SMEs relative to their review of the Lesson Specifications have not as yet been received. It is assumed that any changes based on that review will be discussed and implemented by the Navy/contractor ISD Team prior to any media production.

SECTION IV

COST ANALYSIS

CONTRACTOR AND NAVY MANHOURS

Table 7 is a comparison of Contractor work effort, by task and skill, with the proposed program schedule and the estimated actual level of effort required to complete Phase I. The effort is expressed in manmonths.

The NAVY effort is not available by task, but has been estimated by the SMEs to total 5.5 manmonths for VA-42 and 2.25 manmonths for VA-128 for the entire Phase I effort.

ADMINISTRATIVE AND SUPPORT COSTS

Clerical and administrative effort is an element of overhead and, as such, was not separately identified in the proposed program schedule. It is estimated that 15 manmonths of this effort were expended on Phase I.

OTHER COSTS

In addition to the direct and indirect labor costs noted above, approximately $27,500 was identified for data computing services, and $4,000 was allocated for travel. Both these amounts were expended.

TABLE 7. COSTS - CONTRACTOR WORK EFFORT

Task	Proposed Work Plan (in M/M)	Estimated Actuals (in M/M)
• Work Plan & Quarterly Reports		
- Instructional Psychologists	0.5	0.5
- Educational Specialists	0.5	0.5
• Task Analysis		
- Instructional Psychologists	4.5	9
- Educational Specialists	3.5	6
- Flight Crew	3	6
• SBOs		
- Instructional Psychologists	2	6
- Educational Specialists	9	11.5
- Flight Crew	0.5	0
• Media Analysis		
- Instructional Psychologists	0	4
- Educational Specialists	2	4
• Lesson Specifications		
- Instructional Psychologists	2	2
- Educational Specialists	10	9
- Flight Crew	0.25	0
• Final Report (Preliminary)		
- Instructional Psychologists	2	4
- Educational Specialists	2	3
- Flight Crew	0.25	0
• Final Report (Final)		
- Instructional Psychologists	0.5	0.5
- Educational Specialists	1	1
TOTAL CONTRACTOR EFFORT	43.5	67 M/M
TOTAL SME EFFORT	N/A	7.75 M/M

SECTION V

CONCLUSIONS

The conclusions found in this section are of various kinds. Some relate directly to the aircrew training program, some to the ISD process, still others have elements which relate to both.

a. Operational oriented SMEs, such as the pilot and B/Ns who participated in this study are not effectively utilized if performing lengthy, highly analytical ISD tasks, such as writing SBOs. They are more efficiently utilized as sources of technical and operational expertise. Our experience in this study confirmed the efficacy of utilizing SME in this role.

b. In the conduct of the ISD process there is an advantage in separating the Criterion Test Statement from its associated Behavioral Statement. By so doing, the Behavioral Statement retains its relationship to the operational condition and standards, while the Criterion Test Statement can be adjusted to accomodate learning conditions and standards where they differ from the operational environment.

c. Utilization of SBOs in the development of a Flight Crew Training curriculum should increase the instructors' level of confidence in their student evaluation techniques since the performance measurement tests are constructed using the SBO Criterion Test Statement.

d. The affective domain can be excluded from the Taxonomy of Training Objectives since the Readiness Squadron student population is carefully selected, highly motivated and cautiously screened. The validity of this conclusion has yet to be tested.

e. A significant number of training requirements would best be satisfied using Pilot and B/N Procedures Trainers, a TC-4C (TRAM configured), and a WST with visual capability.

f. Sound slide devices and carrels as well as video tape equipment are important elements in the media recommendations. Initial analysis of existing inventories in VA-42 and VA-128 indicates some additional procurements are required.

g. Much of the current A-6 aircraft systems training (which is being conducted by the Naval Air Maintenance Training Group at the onset of the Readiness Squadron program) is not being retained, especially by Replacement B/Ns.

h. Replacement B/Ns do not have the necessary entry level skills and knowledges relative to aircraft operations, to support copilot training early in the Readiness Squadron curriculum.

i. Electronic data processing is highly recommended for ISD processes involving a substantial number of job descriptions, e.g., analysis of shipboard operations.

SECTION VI

RECOMMENDATIONS

This section presents the study recommendations, which include the following:

a. Further analysis and development of quantitative standards for pilot and B/N activities is recommended.

b. In future programs to develop Readiness Squadron training curricula (for other aircraft models), the Training Command terminal behaviors should be examined and compared with the operational tasks before SBOs are generated. If this information is not available, it could be prepared as an outcome of an ISD study of the Training Command.

c. SMEs should not be compelled to function as training analysts, e.g., writing SBOs, performing media analysis. The analytical portions of the ISD process should be left to qualified Educational Specialists.

d. Behavioral Objectives and their associated Criterion Tests should be separate statements, unless the conditions and standards for the operational environment and the training situations are identical.

e. An implementation program (Phase II) should be conducted to verify that there is, indeed, an increased level of instructor confidence in student evaluation techniques based on the use of SBO derived Criterion Test Statements.

f. The decision to exclude the affective domain from formal consideration during tbe development of the curriculum should be examined during the validation portion of an implementation program.

g. It is recommended that the necessary action be initiated to procure pilot and B/N Procedures Trainers, TRAM configured TC-4C, and a visual capability for the WST.

h. A Phase II program should include the procurement of necessary sound-slide devices, learning carrels and video tape equipment.

i. The aircraft systems training currently being done by the Maintenance Training Group, should be done by the Readiness Squadron as part of the Familiarization Phase. The content of that training should reflect an operational rather than a maintenance orientation.

j. The copilot training given the RBNs, including the relevant portions of the aircraft systems training, should be placed later in the curriculum.

k. Consideration should be given to completion of computer-based data management systems to permit easy updating of changes in ISD based training program.

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Appendix A

SUMMARY OF PILOT LESSON SPECIFICATIONS

Classroom				Flight/WST/PT	
Phase	Units	Lessons	Time Hr	Trainers	Time, Hr
P1.0-Pilot Familiarization	P1.1-Pilot Cockpit Familiarization	P1.1.1 Pilot Cockpit Familiarization	4	PT (WST) A-6E/TRAM	4 2
	P1.2-A/C Systems Familiarization	P&B 1.2.1-Engine Fuel & ECS	3		
		P&B 1.2.2-Hydraulic & Electrical Systems	2		
		P1.2.3-Flight Controls, AFCS, ACIS & APC	3		
		P1.2.4-Instruments & Radio Communication and Navigation	3		
		P1.2.5-VDI, MA-1, VGI & ACU	3		
	P1.3-Normal Operating Procedures	P&B 1.3.1-Pre-Flight Exterior Inspection	2	PT A-6E/TRAM	1 5
		P&B1.3.2-Hand Signals for A/C Operations	1	WST A-6E/TRAM	2 1
		P1.3.3-A/C Ground & Air Procedures	2	PT WST	2 4
		P&B1.3.4-Standard Operating Procedures	1	A-6E/TRAM	4

Appendix A

SUMMARY OF PILOT LESSON SPECIFICATIONS (cont'd)

Classroom				Flight/WST/PT	
Phase	Units	Lessons	Time Hr	Trainers	Time, Hr
P1.0-Pilot Familiarization (cont'd)	P1.3-Normal Operating Proced. (cont'd)	P1.3.5-Formation Procedures	1.5	A-6E/TRAM	9
		P&B 1.3.6-Local Course Rules & Communications Procedures	1.5	A-6E/TRAM	3
		P1.3.7-Night Instrument Procedures	1	A-6E/TRAM	'3
		P&B 1.3.8-Introduction to NATOPS Charts and Graphs	1.5		
		P1.3.9-A/C Limitations	1.5		
	P1.4 A/C Emergency Malfunction Proced.	P&B 1.4.1-Immediate Action	4	PT WST	4 6
		P&B-Deferred	4	PT WST	4 6
P2.0-Visual Weapons	P2.1-Conventional Weapons	P2.1.1-A/C Interfaces & Operational Characteristics	3		
		P2.1.2-Ordnance Characteristics, Typical Loads & Delivery Modes	1.5		

Appendix A

SUMMARY OF PILOT LESSON SPECIFICATIONS (cont'd)

Classroom				Flight/WST/PT	
Phase	Units	Lessons	Time Hr	Trainers	Time, Hr
P2.0-Visual Weapons (cont'd)		P2.1.3-Ballistics Characteristics of Visual Weapons Ordnance & Introduction to Tactical Manual	1.5		
	P2.2-Visual Weapons Delivery	P2.2.1-Visual Bombing Geometry & error analysis	3	WST A-6E/TRAM	1 1
		P2.2.2-Visual Delivery Techniques	1.5	A-6E/TRAM	5
		P2.2.3-Systems Knowledge for Visual Attacks	2	A-6E/TRAM	5
		P2.2.4-Multiple A/C Mission Briefing	1		
P3.0-Tactics	P3.1-Air Combat Maneuvering	P3.1.1-Introduction to Air Combat Maneuvering	3	A-6E/TRAM	7
		P3.1.2-Air Refueling	1	A-6E/TRAM	3
P4.0-Carrier Qualification	P4.1-Carrier Operations	P&B 4.1.1-Introduction to Carrier Operations	3	WST A-6E/TRAM	2 10
		P&B 4.1.2-Hand & Flashlight Signals	1/2	A-6E/TRAM	1

Appendix A

SUMMARY OF PILOT LESSON SPECIFICATION (cont'd)

Classroom				Flight/WST/PT	
Phase	Units	Lessons	Time Hr	Trainers	Time, Hr
P4.0-Carrier Qualification (cont'd)		P4.1.3-IMU Alignment	1	PT WST	1 1-1/2
		P4.1.4-ACLS	1	PT WST A-6E/TRAM	1 2 6
		P4.1.5-Landing Techniques	2	A-6E/TRAM	14

Notes:

1. Trainers identified in parenthesis are alternatives if the primary one listed is either non-existent or not available.

2. This syllabus is based on the present WST design which does not have the capability to simulate FLIR displays and visual cues. Incorporation of FLIR and visual capability in the WST would increase its use and reduce A/C time.

3. An unmodified A-6E may be used in some cases where an A-6E/TRAM has been identified.

Appendix B

SUMMARY OF B/N LESSON SPECIFICATIONS

Classroom				Flight/WST/PT	
Phase (Course)	Units	Lessons	Time Hr	Trainers	Time, Hr
B1.0-Navigation	B1.1-Basic Navigation	B1.1.1-Basic Search Radar Navigation	5-7	PT (WST) WST TC-4C	5-6 1-1.5 1.5-2.5
		B1.1.2-Search Radar and Computer Navigation	5-7	PT (WST) WST	6-7 14-16
		B1.1.3-Search Radar, Computer & CAINS Navigation	4-5	PT (WST) WST	9-11 3-4
		B1.1.4-ADC and Doppler Radar	3-4	PT (WST) WST TC-4C	4-5 4-5 1-2
		B1.1.5-Horizontal and Vertical Navigation Modes	2-3	PT (WST)	2.5-3.5
		P&B 1.1.6-Mission Planning	6-8		
		P&B 1.1.7-Dead Reckoning Navigation	3-4	WST TC-4C	5-6 1.5-2.5
		B1.1.8-Normal A/C Procedures	2-3	PT (WST) WST	6-11 1.5-2.5

Appendix B

SUMMARY OF B/N LESSON SPECIFICATIONS (cont'd)

Classroom				Flight/WST/PT	
Phase (Course)	Units	Lessons	Time Hr	Trainers	Time, Hr
B1.0-Navigation (cont'd)	B1.2-Advanced Navigation	B1.2.1-Data Replacement-NMATSZ	0.5-1		
		B1.2.2-Search Radar Tracking Modes	2.5-3.5	PT (WST) WST TC-4C (A-6E/ TRAM	1-2 1.5-2.5 1-1.5
		P&B 1.2.3-Search Radar Terrain Clearance	2.5-3.5	WST A-6E/TRAM	6.5-7.5 10-12
		B1.2.4-DRS Target Tracking	5.5-6.5	PT (WST) WST TC-4C A-6E/TRAM (TC-4C)	2-3 3.5-4.5 5-6 3-4
		B1.2.5-AMTI, Landing Mode & Video Tape Recorder Operation	3-5	PT (WST) WST TC-4C	2.5-3 5-6 2-3
B2.0-Target Acquisition & Weapon Delivery	B2.1-Weapons System Delivery Characteristics	B2.1.1-Bombing Theory-A/C and Weapons Characteristics and Limits	4-6		
		B2.1.2-ACU and Weapon Release	3-5	PT (WST) WST	5-6 0.5-1.0
	B2.2-Normal Weapon Delivery Modes	B2.2.1-Step Into Attack	1.5-2.5	PT (WST) WST	1.0-1.5 0.5-1.0

Appendix B

SUMMARY OF B/N LESSON SPECIFICATIONS (cont'd)

Classroom				Flight/WST/PT	
Phase (Course)	Units	Lessons	Time, Hr	Trainers	Time, Hr
B2.0-Target Acquisition & Weapon Delivery (cont'd)		B2.2.2-Impact Error Analysis	1.5-2	PT (WST) WST	1.5-2.0 1.0-1.5
		P&B 2.2.3-Primary Attack Modes	10.5-12.5	PT (WST) WST A-6E/TRAM	1.0-1.5 8.5-9.5 17-18
		P&B 2.2.4-Secondary Attack Modes	2-2.5	WST A-6E/TRAM	4-4.5 3-4
		B2.2.5-Visual Weapons Systems	3-4	A-6E/TRAM	8-11
	B2.3-Specific Target	B2.3.1-Target Location, Identification & Track	7-8	WST TC-4C A-6E/TRAM	3-4 10-11 5-6
	B2.4-Degraded Weapon Delivery Modes	B2.4.1-System Advisory Codes (SAC)	1.5-2	PT (WST) WST	3-4 1-2
		P&B 2.4.2-VDI Malfunction Indications	1.5-2	PT (WST) WST	3-4 1-2
		P&B 2.4.3-WRA Malfunctions and Associated Weapon Delivery Modes	2-3	WST	3-4

Appendix B

SUMMARY OF B/N LESSON SPECIFICATIONS (cont'd)

Notes:

1. Trainers identified in parenthesis are alternatives if the primary one listed is either non-existent or not available.

2. This syllabus is based on the present WST design which does not have the capability to simulate FLIR displays and visual cues. Incorporation of FLIR and visual capability in the WST would increase its use and reduce A/C time.

3. An unmodified A-6E may be used in some cases where an A-6E/TRAM has been identified.

LIST OF ACRONYMS

A/C	Aircraft
ACLS	All-Weather Carrier Landing System
ACU	Armament Control Unit
AFCS	Automatic Flight Control System
AFM	Air Force Manual
AFP	Air Force Pamphlet
AGL	Above Ground Level
AMTI	Airborne Moving Target Indication
ATC	Air Training Command
B/N	Bombardier/Navigator
CAINS	Carrier Aircraft Inertial Navigation System
CAS	Close Air Support
CE	Circular Error
CEP	Circular Error Pattern
CNI	Communications Navigation Instrumentation
CPU	Central Processor Unit
CRT	Cathode Ray Tube
CT	Criterion Test
DR	Dead Reckoning
DRLS	Digital Radar Landmass Simulation
DRS	Detecting and Ranging Set
D/T	Demonstration/Test (Phase)
DVRI	Direct View Radar Indicator
ECM	Electronic Counter Measures
EO	Enabling Objective
EW	Electronic Warfare
FAC	Forward Air Controller
FAM	Familiarization
FCLP	Field Carrier Landing Practice
FLIR	Forward Looking Infrared
GAC	Grumman Aerospace Corporation
IBM	Instructor Bombardier

LIST OF ACRONYMS (Cont'd)

IFR	Instrument Flight Requirements
IL	Initial Learning (Phase)
INS	Inertial Navigation System
I/O	Input/Output
IP	Instructor Pilot
IR	Infrared
ISD	Instructional Systems Development
KTs	Knots
MSL	Mean Sea Level
NAS	Naval Air Station
NFO	Naval Flying Officer
NTEC	Naval Training Equipment Center
P	Practice (Phase)
PCB	Pilots Control Box
PT	Procedures Trainer
RBN	Replacement Bombardier/Navigator
RTI	Radio Target Identification
RP	Replacement Pilot
SAT	Systems Approach to Training
SBO	Specific Behavioral Objectives
SCEPTR	Suitcase Emergency Procedures Trainer
SERE	Survival, Evasion, Resistance, and Escape
SME	Subject Matter Experts
TAC	Tactical
TAR	Task Analysis Record
TO	Terminal Objective
TRADOC	U.S. Training and Doctrine Command
TRAM	Target Recognition Attack Multisensor
VDI	Vertical Direction Indicator
VFR	Visual Flight Requirements
VIS WEPS	Visual Weapons
WST	Weapons Systems Trainer

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